

SteamVR: We immerse ourselves in the HTC Vive



CUSTOM PC

THE BEST-SELLING MAG FOR PC HARDWARE, OVERCLOCKING, GAMING & MODDING / ISSUE 153

HOW TO

BUILD A TINY 8-CORE 4K GAMING PC

SQUEEZE TOP PC HARDWARE
INTO A SHOEBOX-SIZED CASE

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COOLED

OVERCLOCKED
TO 4GHz

MODIFIED CASE

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Custom PC Issue 153



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Super-fast water-cooled PCs don't have to double as monoliths. In fact, if you're prepared to get out your Dremel and pretend you're a modern-day MacGyver, you can squeeze an 8-core CPU, GeForce GTX 980 Ti card and water-cooling loop into a shoebox-sized case.

Creating a striking PC like the one on this month's cover isn't easy, but it can be done. You'll need to start with our guide to reorientating your hardware on p102, then move to the build guide on p82. Don't worry if the thought of hacking up your case makes you wince – we also cover alternative options for building a similar system. Even if you don't follow our feature to the letter, we hope it strikes an imaginative spark, and spurs you to take your PC-building skills to the next stage.

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SteamVR We immerse ourselves in the HTC Vive

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38 94



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Windows 10 Home

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6GB Nvidia® GTX 980 Ti Video Card
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4GB Nvidia® GTX 970 Video Card
NZXT H440 Gaming Case
CoolerMaster B600 B2 Power Supply
Corsair H55 Cooling System
LCD monitor is not included but optional



HD 7.1

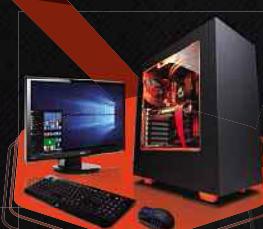


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Windows 10 Home

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2GB Nvidia® GTX 960 Video Card
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BEN HARDWIDGE / FROM THE EDITOR

THE DAWN OF REALITY

People need to try VR for themselves for it to truly revolutionise gaming, says Ben Hardwidge

Earlier this year, stories started circulating about Nintendo ceasing production of the Wii U. Few people were surprised. At the end of last year, the console had sold just 12.6 million units three years after its launch. Comparatively, the Wii sold over 50 million units after its first three years. Anecdotally, my (few) Wii U-owning friends put some of the blame on people not really understanding the Wii U, saying you really need to have a go on one yourself to understand the fun of the controller, and it's difficult to get that across in a TV or online advert.

That's often a problem when a tech company invests in very new ideas, and it's what's going to make or break VR. This month I tried the HTC Vive (see p18) in Overclockers UK's VR room. It's amazing, but despite my best verbal efforts, you really need to try it yourself to really appreciate it. A few photos of me waving my arms around in a headset won't translate the experience, nor will a pair of circular screenshots that show what you get in each eye. I could print out an A3 game screenshot and wrap it around your head, but I don't think that would help either.

People in the tech industry are excited about VR, and understandably so. Many people are describing it as the future of gaming, and they may well be right. But VR is only going to happen if people buy into it, and that requires people to use it for themselves, especially when the systems cost so much money – the Vive will set you back £700, for example, and it makes some serious demands of your hardware too. The Vive also requires you to have plenty of space for you to move around, and dedicating that kind of space to VR is going to be a tough ask for some people in the midst of a housing crisis too.

I could print out an A3 game screenshot and wrap it around your head, but I doubt it would help

There's an obvious comparison with stereoscopic 3D here, which notably failed to take off in gaming and TV, despite the industry's best marketing efforts. But VR is so much better than stereoscopic 3D – it's a proper, full immersion experience. I remember watching the Better Than Life episode of Red Dwarf when I was a kid, and thinking it was funny but basically ridiculous – computer games just weren't like that. Now it doesn't seem so far-fetched.

VR is still in its infancy, of course. We need higher-resolution headsets to prevent objects from looking so pixelated up close and, more importantly, we need plenty of software and game support. With Valve putting its might behind the Vive, you'd think that game support wouldn't be an issue, but the lack of big games for SteamOS after years of development suggests Valve isn't quite the big force it needs to be here. On the plus side, it also helps that Facebook is putting its weight behind the Oculus Rift as well.

For VR to truly take over gaming, it needs to keep developing, and that requires money, commitment and lots of people using it. It's a chicken and egg situation, and 2016 is the crucial year. Either people are going to buy into VR now, and it's going to truly revolutionise gaming, or it's going to be another Wii U, selling in disappointing numbers because people don't get what's so good about it, and then becoming another entry in the 'hey, remember this?' archives for nostalgic TV shows. I love VR, but at this point, I honestly don't know whether it's really going to take off or not. If you're interested in trying it out, I suggest booking a VR demo session with the HTC Vive at www.overclockers.co.uk

Ben Hardwidge is the editor of Custom PC. He likes PCs, heavy metal, real ale and Warhammer 40,000. Email: editor@custompcmag.org.uk Twitter: [@custompcmag](https://twitter.com/custompcmag)



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RICHARD SWINBURNE / VIEW FROM TAIWAN

WILL MICROSOFT EVER GET PC GAMING RIGHT?

Microsoft's Universal Windows Platform needs a drastic rethink if it's going up against Steam, argues Richard Swinburne

Universal Windows Platform (UWP) allows developers to code one app and roll it out onto all Windows 10 devices, whether it's a phone, tablet, laptop, PC or Xbox. However, the apps generally end up looking like those childish, colour-filled 'Metro-apps' that so many people hated in Windows 8. Microsoft may have good intentions, but it behaves as if it hasn't learned from its past mistakes.

PC users generally aren't interested in apps or games designed for touch-screen-centric devices. The ecosystem for apps is far more fine-grained than just one size fits all; PCs are many times more powerful, and play completely different titles; I'm never going to play a typical PC title on my phone, regardless of the fact that Windows 10 phones have little market share anyway.

UWP also means that the limitations of other platforms are dragged onto the PC. At the moment, UWP has no support for CrossFire or SLI, or the ability to run games in full-screen mode without borders. There's also no support for FreeSync or G-Sync and Microsoft locks down the game files, so it's difficult to mod games, let alone benchmark them. For enthusiasts, it all sounds awful, right? Well, Microsoft recently started pushing out popular titles – Gears of War, Forza and the highly anticipated Quantum Break, exclusively with UWP baked into them.

Not only that, but only Windows 10 users get access to these games, and there's no availability on Steam or other retail channels – these games can only be bought through Microsoft's own store, so there will be no refunds or access to large communities. Oh, and, Gears of War launched as an unplayable mess, while Forza will be a free-to-play (pay-to-win) title.

This approach has resulted in a volcanic explosion of anger, with Epic CEO Tim Sweeney blowing his top in a *Guardian* op-ed piece, in which he said that 'PC UWP can, should, must, and will die as a result of industry backlash'. I can see why.

As you can expect, Microsoft has been furiously riding the PR wagon, doing its best to tell people the problems will be fixed. *Gears of War* recently had a big update to correct issues, and Microsoft has stated that support for multi-GPU setups and adaptive sync tech is coming to UWP, but I've yet to see commitment to modding or benchmarking support, and there's no timeline for fixes either.

Nevertheless, none of these issues has delayed the roll-out of exclusive UWP games.

Windows 10's gaming efforts are now controlled by the head of the Xbox team, Phil Spencer, so it comes as no shock that he wants to 'unify PC and Xbox One platforms'. Microsoft thinks PC and Xbox gamers want to be able to cross-play between platforms. Frankly, I couldn't care less when there are already several million people already on Steam, and I doubt the Xbox folks are in a rush to get their arses handed to them by PC gamers either.

Microsoft has to admit that it not only has to fix UWP, but that it also has to offer more than PC gamers have now: modding, benchmarking and every other feature you can already find on Steam, or it will risk another Games for Windows Live-style catastrophe. It has to get its head around the fact that the flexible and cutting-edge PC gaming experience is nothing like the general 'good-enough' approach console gaming, even if there are common titles. Spencer's closed-garden Xbox approach comes across as authoritarian when it's brought to the PC, and PC gamers and developers expect more. **CPC**

Richard has worked in tech for over a decade, as a UK journalist, on Asus' ROG team and now as an industry analyst based in Taiwan  @Bindibadgi



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Letters

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Following protocol

Antony's brilliant PC building tips feature has a bit of a gotcha. If you already have (for example) Windows 10 installed on a SATA SSD, and IDE is set in the BIOS, just changing IDE to AHCI in the BIOS will mean the system won't boot, as it can't see the boot drive.

There's a registry hack that works, but using it comes with the usual risks. I thought this might be worth flagging.

DAVID BOWNES

Antony: Hi David, while our feature was focused on building a new PC and applying AHCI from the outset, you are of course correct and this is a valid point for anyone applying our tips to an existing PC. Thanks for pointing that out!



Gene genie

Your magazine's micro-ATX PC in the Elite list includes an Asus Maximus VIII Gene motherboard with a Samsung SSD 959 Pro M.2 drive. I've just completed a new build based on these recommendations, but the motherboard fails to boot, showing a Q Code fault of 'dd'. It seems the motherboard doesn't recognise the Samsung M.2 drive. I'm still searching for a solution or a workaround. Presumably your technicians have solved this problem. I would be grateful if someone could please help and send me some guidance?

GRAHAM KENNEDY



Set your drive protocol from IDE to AHCI before installing Windows, rather than afterwards

Ben (via email): This isn't a problem I've seen before, but it looks as though early versions of the Maximus VIII Gene BIOS had some compatibility problems with Samsung M.2 drives. Have you tried updating the BIOS to the latest version? Hope you get it working!

Graham: You were correct. After emailing you, I bit the bullet and updated the BIOS. With the latest BIOS installed, the problem was solved and my new PC is up and running (my first foray into water cooling). I still have some work to do to complete the build, but it's hopefully not too bad for a pensioner. There's no graphics card as yet – I'm going to assess the i7 graphics before shelling out on a new card.

Ben: Great, I'm glad your system is all working fine. If any of our readers have the same trouble, then it's good to know a BIOS fix is all that's needed. The integrated graphics will be fine unless you want to play games on it at decent settings.



Code to joy

I'm 42, and I too grew up doing as much coding as gaming, mainly on my BBC Micro. I ended up with a job in IT, so I remained coding until 2012 when I moved to the Danish island of Bornholm. Taking the usual immigrant's path of becoming a cleaner, I have recently found that itch to get coding returning.

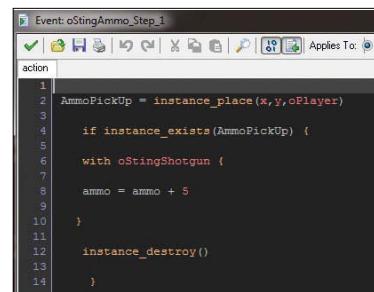
First, I started to learn some Python, which was fine, but

recently I've turned to Game Maker and had a lot more fun. While you can make games by dragging and dropping premade actions in Game Maker, you can also choose to always code your game yourself. This setup allows me to feel like I'm writing everything, but the process is still accelerated and I get a working result much faster.

After a few days of YouTube tutorials and half a dozen test games, I've already begun creating an original work with lighting and particle effect systems. I spent a whole day last week just getting my player character to walk into a door on one screen, and then emerge from another door on the next screen. It was a ridiculous amount of time, but I worked out the code myself and the feeling of accomplishment was immense. Perhaps this could be a route to recapturing those days of our youths, but with the more limited free time of adulthood.

STEVE JONES

Ben: Indeed, our games editor Rick has had a lot of fun with Game Maker, playing with both code and the drag and drop interface, to make a spider game – he's written several pieces about it over the past year. Maybe I should start having a play with it too. **CPC**



Game Maker lets gives you a drag and drop interface with premade actions, but you can also choose to code the games yourself

WHEN'S THE NEXT MAG COMING OUT?

Issue 154 of Custom PC will be on sale on Thursday, 19 May, with subscribers receiving it a few days beforehand.





Twitter highlights

Follow us on Twitter at @CustomPCmag

Deangriffiths14 I am going to build an amazing custom PC. Out with the old, in with the new. @TwitterGaming @CustomPCMag Intel i7-6700K, Maximus VIII, 1TB SSD
Ben: Good luck!

sirbenjaminnunn Moving up the @CustomPCMag @foldingathome leaderboard is like swimming one-handed through cement these days!
Ben: Yeah, we've been folding for a very long time now, so there are a lot of users in there, plus most of the folks at the top of the leaderboard use some seriously powerful kit.

ImCinderz Get a rabbit they said. Damn fur ball went right through my Corsair headset cable.



_upthesaddlers What's up with the images in Issue 152? 2 @GIGABYTE_GBT 980s in one picture but 2 @msitweets 980 in the picture next to it!

Ben: I assume you mean the images in the Overclockers Titan Finesse Phoenix review on p60. Overclockers supplied the original images for the review, but we noticed they had two graphics cards, rather than one, while proofreading shortly before we went to press. We replaced the main image, but forgot the second one as we were so close to deadline. Sorry if it caused any confusion. The machine definitely comes with one (MSI) graphics card.

seismicfootstep @CustomPCMag Really disappointing to see you recommend disabling UAC. Terrible idea.
Ben: It might be a bad idea for inexperienced users, but it's a nagging nuisance if you know what you're doing, and we assume our readers have a decent amount of tech knowledge.

linuxnewbie Fascinating article on ZX Spectrum era coding @CustomPCMag. Would definitely like to read and learn more on this subject.
Ben: The best way to learn more about retro coding is probably to have a go yourself. Download one of the old Usborne books from <http://tinyurl.com/UsborneCoding> and try out some of the code in an emulator.

wellrandom Reading Ben's opinion @CustomPCMag. Would it kill Microsoft or Apple to include a simple version of BASIC with the OS to encourage simple coding?
Ben: I've often wondered the same, and I wonder if it would actually be useful. BASIC has pretty much had its day now, perhaps with the exception of VisualBasic. Python or C could be very useful though.

Liam000000 Hi guys great mag this month BTW. Do you have any plans to do a monster case review? Many years ago you done a great one.
Ben: I assume by 'monster' you mean a big group test of several cases, rather than one review of a massive case? If that's the case, we have an ATX case Labs coming up in Issue 154.

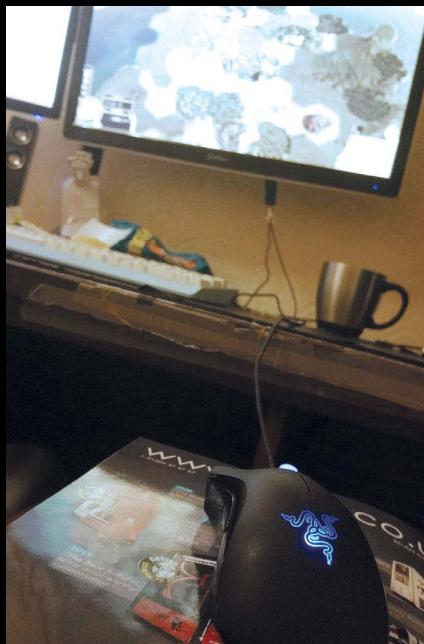
Zimtok5 It would be good to see a VR rundown and eventually some HMD mods in a future @CustomPCMag edition. @oculus @htcvive #forwardthinking.)
Ben: Check out our coverage of the Vive on p18. We hope to be looking at more VR stuff in the future too.

steve murphy02 Bored of black/red scheme, think it's time for some



changes. Suggestions? #Corsair #Crucial #MSI #Radeon @CustomPCMag
Ben: Think it's now time to think about a full custom water-cooling loop!

CammRobb90 And when you're done reading the mag it doubles as a handy armchair deployable mouse mat!
Ben: Ha, I'm glad it's not just me who has done that. I've also been known to use an occasional back issue as a mat when I have my dinner on my lap too.



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TRACY KING / SCEPTICAL ANALYSIS

I PREDICT A RIOT

Can you reduce griefing in League of Legends by priming gamers?
Tracy King discusses a new paper in Nature that suggests it's possible

Nature magazine, one of the most respected science journals, isn't known for hyperbole, so when it published: 'Can a video game company tame toxic behaviour? Scientists are helping to stop antisocial behaviour in the world's most popular online game. The next stop could be a kinder Internet', it's reasonable to assume there's substance behind the headline.

The game in question is League of Legends, and anyone who plays it (or any other online game) will be no stranger to abusive behaviour. The Nature article rightly describes this behaviour as 'griefing', and Riot Games is so concerned about it that it hired some scientists.

The lead researcher is Jeffrey Lin, who has a PhD in cognitive neuroscience and used to work at Valve. Now he's at Riot, trying to work out why a game made by a company literally named after social misbehaviour is attracting social misbehaviour. Anyway, snarky observation aside, the results of Lin and co's research are very interesting. They claim that while 1 per cent of players are consistently nasty, removing them wouldn't change much because they only generate 5 per cent of the nastiness. The rest of the abuse is just from regular players who sometimes lose their temper.

While attributing motives such as frustration to players who send abusive messages is all well and good, for me, a far larger factor is at play in griefing: it's funny. Very funny. To the griefer, their peer group and casual observers. Humour is a major social currency, an easy way to be popular. As the old saying goes, if you need to make a stand, you'd better be funny or they'll kill you. Showing your indifference or invulnerability by making fun of other people is a very natural – if annoying – part of learning to socialise.

The rest of the abuse is just from regular players who sometimes lose their temper

The difficulty is that an immature sense of humour will go for easy targets, which means those with the least social power or privilege. Punching down. That's why the writer of the Nature article, when playing League of Legends for the first time, was immediately called 'FAGGOT'. The more experienced player who sent that pejorative thinks it's hilarious to use homophobic slurs, and believes others will find it funny too.

But whether the motive is frustration, trying to be funny or something else entirely, it's heartening that a major developer is trying to pinpoint the cause and solution to online abuse. In this case, that solution is called priming. Priming is a psychological phenomenon that's been around for a long time, the idea being that you can influence how people behave in controlled conditions by showing them specific stimuli or giving specific feedback.

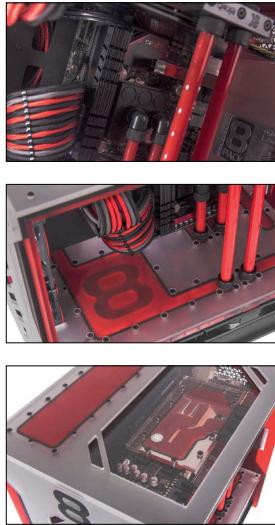
Riot showed LoL players a positive tip, such as 'players who cooperate with teammates win 31 per cent more games'. The tip was presented in either red, white or blue text. Positive tips worked better when shown in blue, and negative tips, such as 'teammates perform worse if you harass them after a mistake' worked better in red. The results are small, but not insignificant, reducing verbal abuse by 6.2 per cent.

However, whether this method works over the long term, or if the effect disappears after a while, remains to be seen. Priming is notoriously hard to replicate, and this research seems to rely on some woolly concepts such as 'blue is often associated with creative thinking in Western cultures', which raises a red... blue flag for me, but it's great to see Riot taking rioting seriously. **CPC**

Gamer and science enthusiast Tracy King dissects the evidence and statistics behind popular media stories surrounding tech and gaming @tkingdoll

Incoming

We take a look at the latest newly announced products



Overclockers launches mini 8Pack rig

Overclockers' resident tweaking guru, Ian '8Pack' Parry has brought his distinctive brand of overclocked, water-cooled PCs to the mini-ITX world, with a dinky powerhouse called the Asteroid. The new system is built into a custom Parvum 8Pack Edition case, which features a built-in water-cooling reservoir, unlike the standard Parvum X1.0, which is mainly designed for all-in-one liquid coolers.

The Asteroid features a Core i7-6700K overclocked to 4.7GHz, 3866MHz Team Group Xtreem memory and a GeForce GTX 980 Ti card overclocked to at least 1450MHz. Meanwhile, a 1kW 80Plus Titanium PSU comes from Superflower, and you get two SSDs in the system. Overclockers has also focused hard on the looks of the machine, which features a full custom water-cooling loop with rigid tubing. Prices for the Asteroid start at £3,990 inc VAT, and will come with a flight case so you can transport it securely. We plan to review an Asteroid system in the next issue of **Custom PC**.



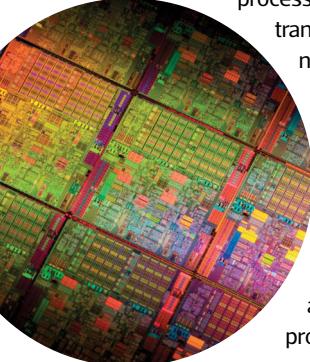
Synology updates two-bay NAS

Acclaimed NAS-box maker Synology has released a new two-bay NAS box that promises read speeds of up to 112MB/sec in a RAID 1 setup using Windows. The DS216j features a dual-core 1GHz Marvell Armada 385 CPU and 512MB of DDR3 RAM, and also supports USB 3. The DS216j's predecessor, the DS215j, has been our Elite-listed NAS box of choice since it was released, so we have high hopes for the DS216j too – we're hoping to get a sample in for review in the next issue of **Custom PC**. The DS216j has a recommended retail price of £126 inc VAT.

Intel abandons tick-tock

In a sign that the semiconductor industry is properly wrestling with physics as transistors get smaller, Intel has surreptitiously dropped its commitment to the tick-tock strategy that's served it well for decades. In the 'tick' part of the cycle, Intel takes its existing processor architecture to a smaller node (with smaller transistors), then the 'tock' features that smaller node in a new CPU architecture.

Intel hasn't publicly made a big deal about the move, but announced it in a 10-K financial report, which was spotted by finance website The Motley Fool. The new move will see the move to a smaller node last through three product lines, rather than two, with the third one being a refinement of the new processor architecture that came with the previous product line-up.



Corsair launches SFX PSUs

Corsair has now joined SilverStone and Be Quiet! in the world of tiny PSUs, announcing two new SFX models for smaller systems. The new SF450 and SF600 are fully modular, feature 80 Plus Gold certification and also proudly sport a 90mm cooling fan to provide effective airflow without making a racket. Not only that, but the fan also only spins up when it's needed, ensuring audible operation at low loads. The SF450 and SF600 are available now from www.scan.co.uk for £70 and £100 inc VAT respectively. We've also used the SF600 in our custom 8-core mini PC this month (see p82).



Reviews

Our in-depth analysis of the latest PC hardware



Reviewed this month

-
- Corsair Gaming Void Surround p17 / HTC Vive p18 / Fractal Design Define Nano S p22 /
Antec H600 Pro and H1200 Pro p24 / Asus Republic of Gamers Swift PG348Q p28 /
HyperX Cloud Revolver p30 / Custom kit p32
-

GAMING HEADSET

Corsair Gaming Void Surround / £70 inc VAT

SUPPLIER www.scan.co.uk / MODEL NUMBER CA-9011144-EU

Corsair Gaming's Void Surround can connect to your PC using a standard 3.5mm audio jack, but its primary connector is USB, as it sports its own sound card. This USB sound card provides virtual Dolby 7.1 surround sound – a feature that's missing on both its Void siblings, although it's purely a software-based implementation. The Void Surround still only has single 50mm drivers, so the effects only offer a small surround effect, but that's the same with most 7.1 headsets. The effect is certainly noticeable, and it helps to increase your perception in games, but it's no match for a decent surround speaker system.

The USB connection also allows you to use the built-in, pull-down microphone, although if your PC or laptop supports 4-pole mini-jacks, you'll also be able to use the microphone with your own sound card. The microphone lacks much of the reposition capabilities we've seen with other headsets though. It's also quite visible in your peripheral vision when deployed,

and doesn't rotate down quite far enough. There's also a shiny metal cap on the microphone, which sometimes reflects light and distracts you when you're gaming.

Thankfully, the microphone offers reasonable recording quality, although the sound lacked bass and sounded a little tinny.

On the plus side, the headset itself is extremely comfortable to wear and sports plenty of adjustment. Its light weight is complemented by a large head cushion and fabric circumaural ear cups. It's comfortable to wear for long periods, although HyperX's Cloud II is still the king in this respect. There's no inline remote either – the volume and microphone mute buttons are located on the left earpiece. Thankfully, they're both large and easy to use, and you have the added benefit of no heavy remote dangling from your ears too.

Sound-wise, the Void Surround excelled in bass-heavy audio, with games especially sounding punchy, detailed and lively, but while drum and bass fans may enjoy this sound balance, it doesn't quite suit music types that make good use of mid and high-range frequencies. That isn't to say the mid and high-range sound quality is poor; it's just isn't as balanced as the likes of the Cloud II. However, the



audio quality was slightly better than that of the standard Void headset, plus you can tweak the sound in Corsair's own CUE software, which sports an equaliser and program profiles. Some of the bass-heavy bias can, therefore, be tuned out with specific profiles that are applied as you launch programs.

Conclusion

The Corsair Gaming Void Surround's main issue is its price. Its introductory offer of £60 wasn't bad, but it now costs around £70. That price is £15 more than that of the original and excellent Hyper X Cloud, and the same price as the Cloud II, which also sports virtual 7.1 surround sound, plus a carry bag, aeroplane adaptor and a flexible microphone boom. While the Cloud II is a better headset at this price, though, Corsair's Void Surround still has a solid and comfortable design, and is recommended if you can find it cheaper.

ANTONY LEATHER



The Void's USB sound card provides virtual Dolby 7.1 surround sound support

SOUND 35/40	DESIGN 26/30	OVERALL SCORE 84%
VALUE 23/30		

VERDICT

A good all-rounder with great comfort and virtual Dolby 7.1 surround sound, but the same money will buy you slightly better sound and more flexibility elsewhere.



PREVIEW

HTC Vive / £700 inc VAT

Ben Hardwidge takes a look at the room-scale technology behind the Steam VR system

SUPPLIER www.occlockers.co.uk

And I'm back in the room. That's good, as it means I haven't been mobbed by zombies because I couldn't work out how to reload my gun after all, but taking the Vive off my head and returning to real life is a truly odd sensation. I've apparently paced around the entirety of Overclockers' new VR room while wearing the Vive headset and trying out the Brookhaven Experiment zombie shooting demo. It isn't a photo-real demo; I clearly wasn't actually there, but the Vive really makes you feel as if you're right there in the middle of the action, and it's bizarre to be returned to the bare walls and empty floor of the demo room.

This year sees a whole load of VR gear being released, including the Oculus Rift, but also Sony's own VR platform on the PlayStation, as well as Samsung's mobile Gear VR system. The Vive is the only VR system that offers what HTC calls 'room-scale' VR technology though. You're not just sitting in a chair wearing a headset; you can position ceiling sensors in two opposing corners of a room and use the whole room as a virtual playground.

Hardware setup

I was initially sceptical about the idea of room-scale VR, as the space is so

If you approach a wall, a blue barrier gently appears in your vision to mark the boundary, which helps as you end up pacing round the whole room

limited, but it works surprisingly well. The Overclockers folks take me through the setup procedure, which is really simple and user-friendly. A cartoon in the setup app takes you through each stage, starting by pointing the two Vive controllers at the monitor, then putting them on the floor, then tracing the outline of the room with them. You can also mark boundaries for any furniture in the room so you won't end up tripping over anything. And that's it; you're then ready to put on the headset and start playing.

The headset itself is covered with UV LEDs that the sensors can use to triangulate its position. Likewise, the controllers are also detected by the sensors, as well as containing various motion-detection hardware. They look a little odd, being basically sticks with an angled circle on the end, but they're comfortable to hold and are USB-rechargeable. Meanwhile, cables are routed through the top of the headband and over your back to prevent you from tripping over them, although Overclockers is considering routing all the cables through the ceiling and mounting the headset to a bungee to remove the issue of cables entirely. Handily, you also get a connection pass-through box with the Vive for easy connecting and disconnecting,





featuring HDMI, USB and analogue audio ports, although the Vive also supports DisplayPort.

You do need to make sure the headset fits properly though. I was happy to find that it worked fine with my glasses, without needing to pop in my contact lenses, but the headset needs to be adjusted so that your eyes are the correct distance from the screens, or your virtual vision becomes severely out of focus.

When it's all set up, though, the experience is surreal. By default, I'm now in a wireframe representation of the room, and I can see the controllers on the floor. I reach down and pick them up, despite the fact that I can only see a virtual representation of them. I then try walking round the room, and it all works well. If I approach a wall or a piece of furniture, a blue barrier gently appears in my vision to mark the boundary before I walk into it, and it becomes more vivid as I get nearer to the boundary.

Software demos

With everything set up, it's time to try out some proper VR software, and I'm given a standard audio headset to provide sound, as there's no audio from the Vive itself. The first demo we try is called theBlu. It places me on an underwater shipwreck surrounded by moving fish. I kneel down to have a look all around me and the experience is mind blowing. You really feel like you're there. Fish are swimming everywhere, and I'm able to walk around the wreck and look anywhere I want. A big whale comes into view later, and you can watch it from any angle you like.

The only slight distraction is that the screens' limited resolution of 2,160 x 1,200 is obvious on the little fish, which all look a little pixelated, with jagged edges, up close. That's a fairly high resolution

on a monitor that's sitting a small distance away from you, but it's not high enough to fool the eye when it's right up close.

Next up is Job Simulator, which is a surreally meta experience. It sounds dull, but it really demonstrates the power of the technology. You can walk around the office and interact with various objects, with your controllers appearing as hands in front of you. The phone rings, so I pick it up with the controller and then bash my head with it, smacking me back to earth and reminding me that I'm not in a virtual office at all. You can pick up objects and throw them, use a computer with a mouse, make a cup of coffee – the controller is very quick and responsive. It all playfully hints at the virtual worlds we may be occupying in the future.

The next demo is an art package called Tilt Brush, which enables you to draw 3D art in your virtual space with the controllers. A cube-shaped menu enables you to select various options, from your environment background (I choose a space scene), to your brush size and shape and



Kneeling down to have a proper look round the view of the aquatic theBlu demo



The strange-looking controllers are responsive and comfortable to hold

Cables are routed through the top of the headband and over your back to prevent you from tripping over them



colour palette. You can then freely draw with the controllers, and walk around your drawing in 3D space – you could draw a circle around you and then walk through it. There's potential to create some great interactive art here.

The final demos we try with the room-scale tech are shooting games, starting with The Brookhaven Experiment, which pits you against zombies from all angles. You can walk around the area to a certain extent, but it's basically a shooting gallery. This time, my right controller has turned into a gun in front of me.

A zombie appears, I shoot it several times, before remembering that zombies, of course, need to be shot in the head. I line up the sights and get a clear headshot. It's like using a light gun from the 1980s, but way better.

Eat my strange-looking guns, zombies!

Another zombie comes towards me and I need to reload, and that's where the first problem occurs. The physical controller I'm holding looks nothing like the gun in front of me, and I can't find the reload button, so I end up getting mobbed by the undead.

We then play Space Pirate Trainer, which is similar in that you can walk around a small space and shoot spaceships, but it's still basically a shooting gallery. This time, though, you have to look up as well as to your left and right. Again, it's good fun, and a neat touch is that you have both a shield and a spare gun in your virtual backpack – you can reach your left hand over your shoulder to take out a shield for defence; do it again and you'll get a second gun. It's like the mouse scroll wheel, but in 3D space.

Elite Dangerous

Of course, the real test of the Vive is how it copes with real games. There isn't a great deal of choice at the moment, but we install Elite Dangerous to get an idea of how it could work. The game recognises the headset natively and sets itself up for the Vive with no trouble at all. Remarkably, setting up the joystick is much more work than setting up the VR system.

This game is also best spent sitting in a chair, rather than pacing round the room. The Overclockers staff say they tried playing it with the room-scale setup, but that you could end up walking outside your ship's cockpit and going into space. I put down the controllers, sit in the chair and put on the Vive headset again.

The experience is still awe-inspiring. I can look down and see the virtual joystick in front of me respond to the exact movements I make to the real-life joystick in my lap. I can look all round the cockpit, above me, and to my left and right. What's more, the use of stereoscopic 3D makes the whole cockpit come to life in a way that makes sense. Your whole field of view (110 degrees, as on the Oculus Rift) is engulfed by the cockpit, so it makes sense that some objects are in



front of others – it's much more realistic than stereoscopic 3D effects coming out of a flat monitor. You can't help thinking that Disney really needs to get to work on licensing a new X-Wing game.

Final thoughts

One thought does strike me about playing Elite Dangerous, though, which is that the experience would likely be the same on the Oculus Rift – there's no benefit of the Vive's controls or room sensors that cost the extra money. The same is likely to be true for most current games too. VR shooting galleries are fun, but you'll need a lot more space to be able to enjoy a first-person shooter, and that's space that most people don't have.

There's great scope for multiplayer VR shooters in a laser tag-style scenario, of course. You can imagine companies hiring big warehouses and kitting out teams with Vive gear to go on a large-scale, virtual shooting spree. But at home, where many people don't have much free space anyway, the Vive could be a difficult sell.

There's also the problem of persuading people that VR is worth buying. After stereoscopic 3D in the home largely crashed and burned, partly because people can't be doing with the faff of putting on glasses to play games or watch TV, the VR industry needs to work hard to get people to part with their cash. As with many new ideas in tech, the best route here is to get people to have a go on it.

You can't gauge the awesomeness of VR from screenshots and pictures of people wearing headsets. You need to try it for yourself. Do that, and you're pretty much instantly sold, because the experience is just mind blowing. All it needs is killer games and software to support it, and people will buy it.

Another issue is the hardware you'll need to cope with the demands of VR. Overclockers reckons a Core i5 and a GeForce GTX 970 are the bare minimum, but you really need all the GPU power you can get (much more so than CPU power). The Vive works fine with the Core i5-6600K system in the OCUK VR room, which has a GeForce GTX 980 Ti card installed. However, it's already clear that VR needs higher-resolution screens in order to really fool the human eye, and that will require even more GPU power. Nvidia and AMD have plenty of work to do.

Gaming isn't the be-all and end-all either. There are massive implications for a product such as the Vive in all sorts of scenarios. You can imagine interior designers



using it to map out a room in your house and then showing you exactly how it will look with different floors and furnishings. You could use it to virtually explore hard-to-reach places in the world – it would be great for showing kids around far-off places in the world.

It remains to be seen whether VR is the future of gaming or just another fad, but experiencing the Vive shows amazing potential, showing that the world of Ready Player One, where we interact with each other in virtual worlds, is no longer a far-off fantasy.

At the moment, there's still some way to go before we reach that stage, and both the Vive and the Oculus Rift will also need decent game and software support on release, but the potential is there.

If you aren't convinced, you can always have a go on the Vive yourself. Overclockers will give you a 15-minute demo between 9am and midday in its VR room, and you can book your slot at www.ocuk.co.uk, where you can also pre-order the Vive for £700 inc VAT, plus shipping. The pre-order bundle includes the sensors and controllers, as well as Job Simulator and Tilt Brush. Overclockers currently expects pre-orders to be fulfilled in May, but availability may end up being later, depending on HTC. **CPC**

The screens in the Vive headset have a resolution of 2,160 x 1,200, but that isn't quite high enough to fool the human eye up close



Position the two sensors in opposing corners of the ceiling and you can use a whole room as a virtual playground

MINI-ITX CASE

Fractal Design Define Nano S / £60 inc VAT (£65 inc VAT with window)

SUPPLIER www.scan.co.uk / MODEL NUMBER FD-CA-DEF-NANO-S-BK

We've already seen one new mini-ITX case from Fractal Design recently, in the form of its excellent Core 500, which offered reasonable water-cooling support and, despite its small size, it could house large air coolers too. The Core 500 was cube-shaped, though, looking quite different from the Fractal's Define Nano S, which is the company's first tower-style mini-ITX case, following in the wake of cases such as NZXT's Manta and Phanteks' Enthoo Evolv ITX.

Like those cases, the Nano S uses a rather familiar layout, with the motherboard mounted vertically, the PSU sitting at the bottom of the case and the fans located in the usual places. While this arrangement

might seem a little predictable for a new mini-ITX case, though, the Nano S is considerably smaller than NZXT's Manta. It's nearly 10cm shorter and almost 5cm shallower too, largely because it lacks the Manta's bulging panels.

However, there's also a tad less water-cooling support. Both cases are very good in this respect, but the Manta can house double 140mm-fan radiators in both the roof and front fan mounts, while the Nano S is limited to double 120mm-fan radiators in the roof. The front fan mounts aren't compatible with all 140mm-size radiators either. The width and height limits of 147mm and 312mm respectively mean that slim, 140mm-sized radiators should fit, but larger, thicker models such as Alphacool's NexXxos UT45 and UT60, for example, will be too tall.

Meanwhile, the roof is covered by a removable plastic shroud by default, but can house practically any height of 240mm-sized radiator thanks to the fan mounts being offset several inches away from the motherboard. However, Fractal does state that there's a height limit of 35mm for motherboard heatsinks and memory modules. There's plenty of scope for radiators, then, but Fractal has also modified the case to include pump and reservoir mounts, with pre-drilled holes and grooves next to the motherboard and a small bracket in front of the PSU. In short, the Nano S is a fantastic case for mini water-cooled systems, whether you're using all-in-one liquid coolers or custom water-cooling gear.

Out-of-the-box cooling is provided by a single 140mm fan in one of the two front 120/140mm mounts, along with a single 120mm model at the rear, with the two roof 120/140mm mounts vacant. There's also a fourth 120mm mount located in the base. The



The case has been modified to include reservoir and pump mounts

can house double 140mm-fan radiators in both the roof and front fan mounts, while the Nano S is limited to double 120mm-fan radiators in the roof. The front fan mounts aren't compatible with all 140mm-size radiators either. The width and height limits of 147mm and 312mm respectively mean that slim, 140mm-sized radiators should fit, but larger, thicker models such as Alphacool's NexXxos UT45 and UT60, for example, will be too tall.

front of the case and the PSU intake are both protected by large removable dust filters too. However, the lack of large vents in the front of the case could be an issue for cooling, with further vents only coming from small cut-outs in the sides and a small hole in the base.

On the plus side, the inside of the case has an ample cable-routing system for most mini-ITX setups, with the helpful addition of Velcro cable ties. There's also an extra-large CPU area cut-out and plenty of options for routing the EPS 12V power cable to the motherboard at the top, which is important, as these sockets are positioned in varying locations on different mini-ITX boards.

Elsewhere, the interior sports noise-absorbing foam on the rear panel, and there are two mounts for either 3.5in hard disks or 2.5in SSDs – one sits behind the large reservoir mount next to the motherboard tray, and the other sits next to the PSU. In addition, there are also two dedicated 2.5in mounts behind the motherboard tray. There's a fair amount of room for CPU coolers and graphics cards as well – we say fair because the smaller Core 500 manages to offer 10mm more CPU cooler clearance, although the Nano S sports an extra 5mm graphics card clearance. Either way, there's enough room to house a decent CPU cooler and graphics card.

Meanwhile, the front panel is located on top of the case and includes power and reset buttons, as well as the usual audio mini-jacks and two USB 3 ports. If you're not using the roof fan mounts, take a look behind the front panel and you'll find a removable cover that can protect against dust and spills. Our sample included a large side window too, which is part of a package that costs £65. If you're not fussed by a side window then you can save yourself £5 and opt for the windowless version. Generally, though, the exterior is nothing to write home about, looking like a mini version of other cases in Fractal Design's range that feature a solid front door and no 5.25in bays.

/ SPECIFICATIONS

Dimensions (mm) 203 x 412 x 344 (W x D x H)

Material Steel, plastic

Available colours Black

Weight 4.6kg

Front panel Power, reset 2x USB 3, stereo, mic

Drive bays 2x 3.5in/2.5in, 2x 2.5in

Form factor(s) Mini-ITX

Cooling 2x 120mm/140mm roof fan mounts (fans not included), 2x 120/140mm front fan mounts (1x 140mm fans included), 1x 120mm rear fan mount (fan included), 1x 120mm bottom fan mount (fan not included)

CPU cooler clearance 160mm

Maximum graphics card length 315mm



1 There are plenty of options for routing the EPS 12V power cable to the motherboard at the top

2 The case features pre-drilled holes and grooves for mounting pumps and reservoirs

3 There's room to install a double 140mm water-cooling radiator in the front, as long as it isn't too thick

Performance

While many small cases struggle to house larger CPU coolers, the Nano S will accommodate plenty of large air coolers. As a result, the low-profile cooler used in our mini-ITX test gear probably isn't revealing its true potential. The fans are relatively quiet and don't shift a lot of air, so it was no surprise to see the more compact Fractal Core 500 outperform the Nano S in both tests. The Nano S bettered NZXT's Manta and Phanteks' Evolv ITX in our airflow results, though, thanks to slightly better ventilation and a more compact size, which likely suited our test gear a little better.

Conclusion

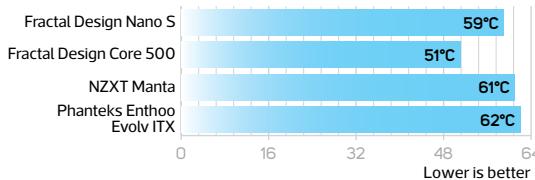
While the Fractal Design Define Nano S isn't revolutionary in terms of layout or looks, it's the best tower-shaped mini-ITX

case we've seen so far. It's smaller than the NZXT Manta and Phanteks Evolve ITX, yet boasts better air cooling and similar water-cooling support. It also has an excellent cable-routing setup, and it's easy to work with the case's interior. It might cost £10 more than the Phanteks Enthoo Evolv ITX, which some people will find better-looking too, but the Nano S also sports roof fan mounts – a feature that would have improved the Evolv ITX's prospects in both air and water cooling considerably.

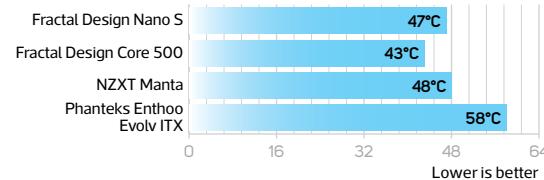
The Define Nano S might not be the perfect mini-ITX case – it's still pretty large and not particularly attractive, but it has more features than the Evolv ITX and is much cheaper than the Manta, while offering all the features you need to build a great mini gaming PC.

ANTONY LEATHER

CPU LOAD DELTA T



GPU LOAD DELTA T



COOLING
24/30

FEATURES
17/20

DESIGN
27/30

VALUE
18/20

OVERALL SCORE
86%

VERDICT

It isn't revolutionary, but the Define Nano S is smaller than some of its competitors, sports excellent features and will make a great home for either an air or water-cooled PC.

CPU COOLER

Antec H600 Pro and H1200 Pro /

£34 inc VAT (H600 Pro); **£55** inc VAT (H1200 Pro)SUPPLIER www.scan.co.uk

Antec hasn't been afraid to try new ideas in the world of liquid cooling, consistently offering products showing out-of-the-box thinking, such as combined pumps and fans, as well as other new ideas, some of which were good, and some of which were not so good. However, the new H600 and H1200 Pro coolers look a little run-of-the-mill, albeit with some neat square edges and compact, clean designs. On the plus side, the fans and Antec logo light up in blue when powered on. It's otherwise all pretty standard except, that is, for the prices.

The H600 Pro retails for an extremely low £34 inc VAT and the H1200 Pro, despite having a dual-fan radiator only costs £55 inc VAT – £11 less than Corsair's single-fan H75. Antec is clearly targeting customers that can't stretch to premium coolers, but still want liquid cooling. In fact, the H600 Pro is cheaper than many large air coolers.

The units are produced by Asetek and use FEP flexible tubing

which Antec claims offers very low evaporation compared with rubber tubing, while also being more flexible, potentially making them good choices for small systems.

The pump and fans are powered separately, unlike Corsair's units, and there's no fan control software included either – the fans are powered by your motherboard headers or a fan controller and use 4-pin cables. Thankfully, Antec has included a Y-splitter cable so you can power both fans on the H1200 Pro from a single header. Meanwhile,

the pump section is powered by a SATA power connector and also sports a pump speed header, so you can set an alarm to sound if it should fail, provided your fan controller or motherboard allows this feature.

The H600 Pro is a single 120mm-fan unit with a half-height radiator, not dissimilar to Corsair's cheaper units. The H1200 Pro is the more potent, dual 120mm-fan model with a single row of fans and a similar half-height radiator. Both coolers are optimised to work in a push airflow configuration.

All the usual CPU sockets are supported, although installation can be a little fiddly. You're well advised to mount the radiator first and use the adhesive pads to secure the rear backplate to your motherboard, whether or not you've removed it. Even so, fitting the four sprung thumbscrews can be tricky on LGA115x systems, as the backplate uses hex-ended



H600 Pro

pins that pass through the mounting holes and secure to the thumbscrews and pump section on the other side. These pins often fall out of their mounting holes, so while you can fix the backplate to the PCB, you'll still need one hand behind the motherboard, holding the pins in place, while you screw the thumbscrews into them. The end result doesn't look elegant either – NZXT and Corsair definitely score higher on aesthetics as well as installation.

Thankfully, though, installation is difficult to mess up, and we managed to install each cooler, radiator and all, in less than 15 minutes.

That said, you'll need to make sure you have adequate room for the radiators and fans. While the H600 Pro is 120mm wide, it's also 155mm tall, so it may not fit in all 120mm fan mounts, especially at the rear of smaller cases.

Performance

The H600 Pro's delta T of 61°C in our LGA115x system, when dealing with our overclocked Core i7-4790K, matched the medium fan speed result of the Corsair H80i GT, which isn't a bad result at all. However, this result was achieved with the fan set at 12V, and it was very loud too, as were both coolers in fact – the H80i GT is significantly quieter.

Meanwhile, the H1200 Pro managed a slightly cooler delta T of 58°C, a temperature that's outdone by the H80i GT on its fastest fan speed, although both coolers are equally loud at this setting. Interestingly, the H75 also beat the H1200 Pro by 4°C although, while the latter is a smaller unit, it also costs 20 per cent more, and still lacks the software fan control offered by its more expensive siblings.

Moving on to our LGA2011 system, the extra cooling power of the H1200 Pro saw it catch up with the Corsair H75, pipping it to the post by 1°C, although producing more noise at full speed. The H80i GT still had an advantage at full speed, though, as did the H110i GT. The H600 Pro, meanwhile, managed a delta T of 52°C, which was only

SPECIFICATIONS /**H1200 PRO**

Compatibility Intel: LGA2011, LGA2011-v3, LGA115x, LGA1366; AMD: AM3/3+, AM2/2+, FM2/2+, FM1

Radiator size with fans (mm) 271 x 120 x 25 (W x D x H)

Fans 2 x 120mm

Stated noise 16–35dB(A)

H600 PRO

Compatibility Intel: LGA2011, LGA2011-v3, LGA115x, LGA1366; AMD: AM3/3+, AM2/2+, FM2/2+, FM1

Radiator size with fans (mm) 155 x 120 x 27 (W x D x H)

Fans 1 x 120mm

Stated noise 16–35dB(A)

enough to scrape ahead of the H80i GT on its medium and low fan speed settings, and again, the Antec cooler was significantly noisier by comparison.

Switching to the motherboard's standard PWM mode saw the fan noise become much more tolerable. At 10V, there was still a fair degree of airflow noise, however, while the fan noise quietened further below 8V, a low electrical hum became evident that was mildly intrusive. This noise will likely be inaudible outside of your case if you mount the fan at the rear, which is possible with the H600 Pro. However, if you mount the cooler in the roof and have a quiet GPU and PSU, the noise may be annoying if you're striving to build a super-quiet PC, although it's definitely an improvement on the fan noise at 12V.

Conclusion

Both the H600 Pro and H1200 Pro offer competitive cooling ability, despite their wallet-friendly price tags. Installation is fiddly and these coolers have few frills, but with LED fans, splitter cables and a SATA power connector for the pump, they're solid efforts in spite of their low cost. They aren't the quietest coolers, though, with a low electrical hum at low fan speeds and loud airflow noise at maximum speed, but if noise isn't major concern then the H1200 Pro is well priced



H1200 PRO

at £55 inc VAT, performing similarly to or better than Corsair's more expensive H75 and giving the H80i GT a run for its money.

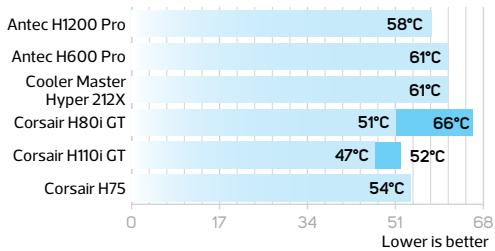
The H600 Pro, meanwhile, is super-cheap at £34 inc VAT, but its cooling ability isn't any better than many similarly priced air coolers. For example, Cooler Master's Hyper 212X, which we reviewed last month, performed similarly in both our test systems and costs £5 less. As such, while the H1200 Pro is worth considering if you want decent liquid-cooling performance on a tight budget and don't care about noise, a decent air cooler will serve you better than the H600.

ANTONY LEATHER

CPU TEMPERATURE

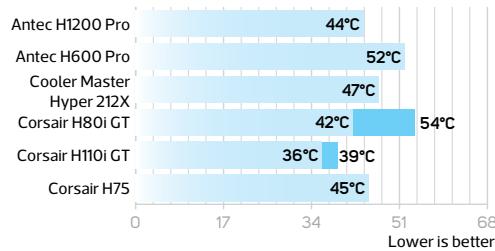
LOAD DELTA T

INTEL LGA1150



LOAD DELTA T

INTEL LGA2011



H600 PRO / LGA115x

COOLING 31/40	DESIGN 23/30
VALUE 26/30	

OVERALL SCORE
80%

H600 PRO / LGA2011

COOLING 29/40	DESIGN 23/30
VALUE 23/30	

OVERALL SCORE
75%

H1200 PRO / LGA115x

COOLING 33/40	DESIGN 23/30
VALUE 27/30	

OVERALL SCORE
83%

H1200 PRO / LGA2011

COOLING 32/40	DESIGN 24/30
VALUE 28/30	

OVERALL SCORE
84%

VERDICT

The H1200 Pro offers decent liquid-cooling performance for an exceptionally good price, as long as you don't care about noise, but the H600 Pro is outperformed by cheaper air coolers.



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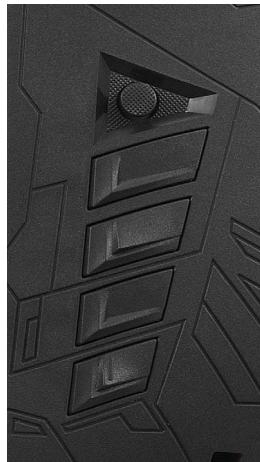


CURVED ULTRA-WIDE MONITOR

Asus Republic of Gamers Swift PG348Q / £999 incVAT

SUPPLIER www.ocuk.co.uk

The on-screen display is controlled by a small joystick and a set of buttons on the back



Large, curved gaming monitors have been arriving in greater numbers, but most of them involve compromise, with comparatively low resolutions, missing features or underwhelming panels. That isn't the case with the Asus ROG Swift PG348Q. This monitor costs a cool grand, but every feature is crammed into it. The PG348Q not only has a curved 3,440 x 1,440 ultra-wide IPS panel, but it also supports Nvidia G-Sync, while sporting flashing LEDs and game-specific screen modes.

The screen's 110ppi pixel density is high enough to keep games looking pin-sharp, but not so high that you'll need to deploy Windows' own scaling settings, which can be a blessing – even today, some software doesn't scale properly. It's a good balance, being sharper than most 1080p and 2,560 x 1,440 panels, but not as crisp as a 34in 4K screen.

Viewing angles are good too, and the keen balance of resolution and size means PCs don't need unreasonably expensive graphics hardware to get games running – the PG348Q's 1440p panel has just under five million pixels, while a 4K screen has more than eight million.

Nvidia G-Sync helps too. The technology links the monitor's refresh rate with a game's frame rate to eliminate screen-tearing and it does a wonderful job – games are butter-smooth, which makes them look even better on the 34in widescreen panel. The

PG348Q also has a maximum refresh rate of 100Hz, which lags behind some 144Hz screens, but it's still plenty for most players.

A host of smaller features contribute to the PG348Q's quality as well. The IPS panel is a true 10-bit screen, rather than a cheaper 8-bit panel, so it can display 1.07 billion colours rather than 16.7 million – Asus says the PG348Q produces 100 per cent of the sRGB colour gamut. It's also finished with a non-glare coating, and the GamePlus feature overlays the screen with a crosshair, fps counter or timer.

Even the pair of 2W speakers isn't awful. They have a narrow range that struggles with high-pitched noises and bass, but quality in the mid-range is reasonable, with good punch and volume. They're a little muffled, but they're usable if there aren't any alternatives.

All these goodies are wrapped inside an extravagant design. The vast screen sits on three wide legs and an angled stand, which is finished in gunmetal grey with burnt orange accents. The stand attaches to more burnt orange-coloured areas, and the rear of the screen is coated with angled, futuristic designs. The base is also full of LEDs that project a Republic of Gamers logo in a dramatic orange glow that stands out on a dark desk – a button alters its intensity, although thankfully, you can also turn it off.

The PG348Q has one of the loudest-looking stands we've seen, but there's good versatility here too. There's 115mm of height adjustment, forwards and backwards tilting and left-

to-right swivelling, which is more movement than you usually find on large screens. The on-screen display (OSD) is good too. It's controlled by a small joystick and a set of buttons on the back, and it's both fast and sensibly organised, although it takes a while to get used to the twitchy nature of the joystick.

The base requires a tad more assembly than most monitor bases, though, with various panels and numerous screws involved. Port accessibility isn't great either; the Asus has four USB 3 ports alongside HDMI 1.4 and DisplayPort 1.2, but all the connectors sit around the back, face downwards and can be hidden behind a shroud. That's fine for permanent attachments, and it looks very tidy, but it's a barrier to quick switching.

Performance

At factory settings, the Asus delivered a solid brightness level of 285cd/m², and that's bolstered by a decent black level of 0.27cd/m². The two results combine for a contrast ratio of 1,055:1, which is excellent – enough to give good depth and variation to black areas while also giving brighter tones plenty of punch.

Colours are accurate too, thanks to an average delta E of 1.74 and a colour temperature of 6,366K. The former result is excellent, and the latter isn't far removed from the 6,500K ideal – certainly not far enough away for most people to tell the difference. The average gamma level of 2.06 isn't bad either. The PG348Q displayed 98.6 per cent of the sRGB gamut, which isn't far removed from Asus' boasts.

We turned down the brightness to a more palatable 50 per cent, which saw the backlight drop to 191cd/m². At this setting, contrast remained at 1,066:1, colour temperature dropped slightly to 6,225K and the average delta E improved to a stunning 0.58. The Asus also delivered good uniformity at this setting. Brightness dropped by a maximum of 12 per cent in the top-right corner, with most segments only losing single-figure percentages. Colour temperature increased by between 1 per cent and 4 per cent in most segments, but that's no problem – it takes the screen's measurement closer to 6,500K.

Those results are better than most ultra-wide panels, which usually suffer because of their sheer size. The only issue was a little backlight bleed in the top-right and bottom-left corners. It's noticeable on a totally black screen, but it's not going to disrupt gameplay. The Asus didn't suffer from input lag either. We measured an average input lag of 13.2ms across the entire screen – better than the 20ms benchmark we expect from gaming panels.

Meanwhile, the RTS/RPG screen mode improves colour saturation and contrast, while the FPS option ramps up contrast to provide better visibility in dark scenes. The Racing option improves response times, while the Scenery setting produces higher brightness levels and contrast gradients.

Despite those claims, the game-specific screen modes proved underwhelming. The RTS/RPG option made little difference to contrast but caused a poorer delta E result, and the racing mode didn't deviate from our factory results. The FPS option had a poorer delta E, and the Scenery setting was even worse.

It's the same story with other screen modes. The Warm colour setting nails the temperature with a result of 6,592K,



but at the expense of colour accuracy and contrast – and the Cool colour mode's result of 9,006K is far too cool. Meanwhile, the dedicated sRGB option offers similar backlight levels to our 50 per cent brightness measurement, but with slightly warmer colours and a worse delta E.

We then calibrated the Asus with our colorimeter. Tweaking the screen involved turning the green colour slider down two notches and ramping up brightness from its default setting of 80 to 85, and it delivered great results: the 287cd/m² brightness level was paired with a 6,312K colour temperature and an average delta E of 0.85.

Conclusion

The Asus PG348Q has a huge number of gaming features. Its widescreen design and 1440p resolution provide ample space and sharpness, with several advantages over taller but narrower 4K panels. There's Nvidia G-Sync, a fast menu, extravagant design and impressive versatility. Colours are accurate, contrast is strong and it has better uniformity than many other ultra-wide panels, plus the curve makes your field of vision look great in front of you.

Problems are minor: a little backlight bleed, some iffy screen modes, a lower refresh rate than you find on some gaming monitors and a comparatively complicated setup procedure. When it comes to screen quality, specifications, features and design, though, the Asus PG348Q nails the brief with flair. It does cost £1,000, sure, but if you have the money, this monitor makes gaming a real pleasure.

MIKE JENNINGS



The stand offers 115mm of height adjustment, forwards and backwards tilting and left-to-right swivelling

IMAGE
45/50

FEATURES
19/20

VALUE
24/30

OVERALL SCORE

88%

VERDICT

Great image quality and a broad feature set, including G-Sync support, make the PG348Q a top-notch gaming panel.

GAMING HEADSET

HyperX Cloud Revolver / £100 inc VAT

SUPPLIER www.scan.co.uk

Unlike the original Cloud and Cloud II, HyperX's Cloud Revolver isn't, as far as we know, a borrowed design from the likes of Qpad and it's plain to see this fact in the design and specifications. It uses slightly smaller 50mm drivers than its predecessors, while the earcups and headband are different shapes and slot together differently. It uses a steel band as a frame that reaches from earcup to earcup, but still sports the same soft, padded headband as the previous Cloud models.

This frame can stretch at the ends, depending on the size of your head, which means you can pop on the headset and, within a few seconds, you're all set up comfort-wise. The downside is that this stretching can impact on the position of the earcups, which can sag down a little. Thankfully, the earcups are otherwise very comfortable on your ears, with well-padded faux leather, although there are no replacements in the box. The earcups can also swivel slightly to adjust to your head's shape, while the ear cushions are circumaural and have large recesses for your ears.

Placing the Revolver on your head reveals one significant issue though – the steel headband is highly sensitive to knocks and vibrations, and the earcups pick up these knocks in a big way. The result is that you end up hearing a lot of unwanted sound, even with the slightest knock. This sensitivity shouldn't be a problem if there's nothing on your head to knock it, but it could be an issue if

you're wearing glasses, or anything that might rub against it, such as a hoodie.

The Cloud Revolver lacks any USB connections and instead uses a fixed 1m detachable, braided cable with a 3.5mm mini-jack to link up to an inline remote. The latter adds a further 2m of cable that splits into respective microphone and headphone mini-jacks to plug into your PC. There's obviously no surround-sound support either, so the hefty price tag is a little questionable when the specification is otherwise similar to HyperX's previous headsets.

Overall, sound quality is very good, with excellent high-end and detailed bass, although the latter lacked the powerful kick we've come to expect from gaming headsets. Some of the mid-range was a little lifeless too, occasionally lacking detail, but this issue wasn't too noticeable. The fantastic high end was evident in vocals and gunfire, and we found it was possible to boost the bass a little using a software equaliser to reduce the rather flat response from



The circumaural ear cushions have large recesses for your ears

/ SPECIFICATIONS

Cup type	Circumaural
Connection	Mini-jack
Driver(s)	50mm
Frequency response	12Hz - 28kHz
Impedance	30k Ohms



drums or explosions. The microphone wasn't quite as high-performing though; its repositionable arm has to be no more than 2-3cm away from your mouth, otherwise the volume falls away sharply. You'll need to speak gently too, as it's susceptible to plosives if your voice gets too excited and blowy.

Conclusion

The Cloud Revolver is a disappointment given HyperX's previously excellent offerings. The sensitive headband and average microphone are two annoying hitches, but the main issue is the price. It's simply too expensive, and we doubt the price will have fallen much by the time it hits the shelves. The Cloud and Cloud II are still available for much less money, and offer superior quality to boot.

ANTONY LEATHER

SOUND
34/40

DESIGN
22/30

VALUE
18/30

OVERALL SCORE
74%

VERDICT

A couple of design issues and a very high price tag means HyperX's new headset isn't what we anticipated.



ND4000 Gaming PC

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Finance Available



ND3000 Gaming PC

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Custom Kit

Paul Goodhead checks out the latest gadgets, gizmos and geek toys

BLUETOOTH SPEAKER

Audio Pro Addon T3 /

£159 inc VAT

The build quality and finish of the Addon T3 simply shout quality, letting you know it's the real deal as soon as you get your hands on it. The brushed metal buttons and leather carry strap are particularly pleasant touches. At £159 inc VAT, you'd rightly expect audio excellence, and again, the T3 has it where it counts. Music sounded unexpectedly rich and full for a unit that's only around the size of a handbag, and while the treble tended to dominate at the very top end of the volume settings, the mix is balance and behaved at normal listening levels. A claimed battery life of 30 hours (at 50 per cent volume) and a rear USB port for charging mobile devices mean the T3 can act as a travel companion, but its great quality will make it equally at home in a living room too.



SUPPLIER www.qvcuk.com



iPAD MINI CASE

BrydgeMini / **£80 inc VAT**

The BrydgeMini is a clamshell-style iPad mini keyboard case made from brushed aluminium, styled to make your tablet look and feel like a dinky MacBook. The result is undeniably cute, and the quality of the case is top-notch; the keyboard is backlit, with solid key action, and the hinge clasps gripped our test iPad perfectly.

Of course, reducing a keyboard down to this size introduces a number of annoyances, such as the tiny Shift keys, but Brydge has done well to at least keep the main letter keys well proportioned. Even so, the typing experience still feels cramped, making tapping out much more than a long email a chore. Elegant engineering can only do so much to mitigate a basic lack of space.



SUPPLIER www.amazon.co.uk

ACTUAL SIZE

MINI COMPUTER

Asus Chromebit/

£91 inc VAT

If you'd have told us a decade ago that we'd be testing a sub-£100 computer the size of a chocolate bar, we'd have probably told you to stop taking so many mind-altering substances. That's precisely the Chromebit's description, though, and it includes a built-in HDMI connection, ready to be plugged into a TV or monitor. As you'd expect, given its size and price, it isn't a computing powerhouse. Inside the Chromebit is a modest Rockchip RK3288C CPU, 2GB of RAM, 16GB of flash storage and an ARM Mali-T764 GPU, all of which power Google's web-centric Chrome OS.

Despite the low-power hardware, however, the experience isn't all that bad, as most of the tasks you'll be performing on the Chromebit are web-based, and Chrome OS is very light on its feet. Playback of 1080p content was smooth, for example, and we didn't find any websites or web apps that the Chromebit was incapable of running.



Being willing to use online tools and put up with their limitations is necessary though. For instance, the Google Docs office suite works well on it, but you get more flexibility from a proper office suite on a PC – Google Docs is great for simple online collaboration, but not so good for individuals creating complicated documents. The web apps for services such as Spotify and Netflix lack some features found in their respective mobile apps as well. Plus, while the Chromebit itself only costs £91, you're likely to want to pair it with a Bluetooth mouse and keyboard, which adds to the outlay.

Overall, though, these are petty niggles. The Chromebit was perfectly capable of handling our everyday email, Web, social media and media streaming needs, which is remarkable for such a cheap and small device. Clearly, it's no desktop replacement, but it's perfectly serviceable as a second PC in a kitchen or bedroom.



SUPPLIER www.dabs.com

HEADSET ACCESSORY

In Win iEar/ **£15 inc VAT**

In Win's bizarrely named iEar is designed to fix the common conundrum of where to put your headphones when they're not on your head. It's little more than an elaborate hook, but it works very well – the sucker in the unit's base stuck fast to every smooth, non-porous surface we tested, and it held firm in one spot for the few weeks we used it. You'll need a suitable nearby surface on which to stick the iEar for it to interest you (and be able to stomach the grumble-worthy £15 price tag), but if you keep your PC on your desk, most side panels will do the trick fine.



SUPPLIER www.box.co.uk



MOUSE MAT

Mionix Sargas XL & XXL/

£20 inc VAT (XL) and £30 inc VAT (XXL)

When we saw the Sargas 900 back in Issue 133, it was the biggest mouse mat we'd seen, but now Mionix has updated the line and introduced a new, even bigger model. In truth, the updates aren't major. The fabric upper now has a Mionix logo and is treated to make it easier to clean. The mats' thickness has also increased by 25 per cent to 2.5mm. In use, the Sargas XL is basically indistinguishable from the 900 model it replaces. It's the same size (90 x 40cm), and the surface tracks equally well. The new XXL model tracks well too, but with its 120 x 50cm dimensions, it actually hung off the edges of our desk, which was faintly ridiculous. Both mats roll up, but even then, they're still big. The Sargas are decent mouse mats if you want as much acreage as possible, but they're also very pricey.

XL

XXL

SUPPLIER www.amazon.co.uk

Seen something worthy of appearing in Custom Kit? Send your suggestions to paul_goodhead@dennis.co.uk

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How we test

Thorough testing and research is the key to evaluating whether a product is worth buying, and deciding whether or not there's a better alternative

PROCESSORS

We judge CPUs on whether they offer sufficient speed for the price. Part of a CPU's speed score comes from how overclockable it is. Every type of CPU is tested in the same PC, so all results are directly comparable.

INTEL LGA1151



Intel LGA1151 CPU
Asus Z170 Deluxe (ASRock Z170 Extreme4 for Core i3 6100 test)
16GB Corsair Vengeance LPX 2666MHz DDR4
240GB OCZ Arc 100

INTEL LGA2011-V3



Intel LGA2011-v3 CPU
Asus Rampage V Extreme
16GB Corsair Vengeance LPX 2133MHz DDR4
512GB Crucial MX100

AMD FM2+



AMD FM2+ APU
MSI A88X-G45Gaming
16GB Corsair Vengeance Pro 2133MHz DDR3 (GPU testing)
8GB Corsair Vengeance Pro 1600MHz DDR3 (CPU testing)
240GB Crucial M500

COMMON COMPONENTS



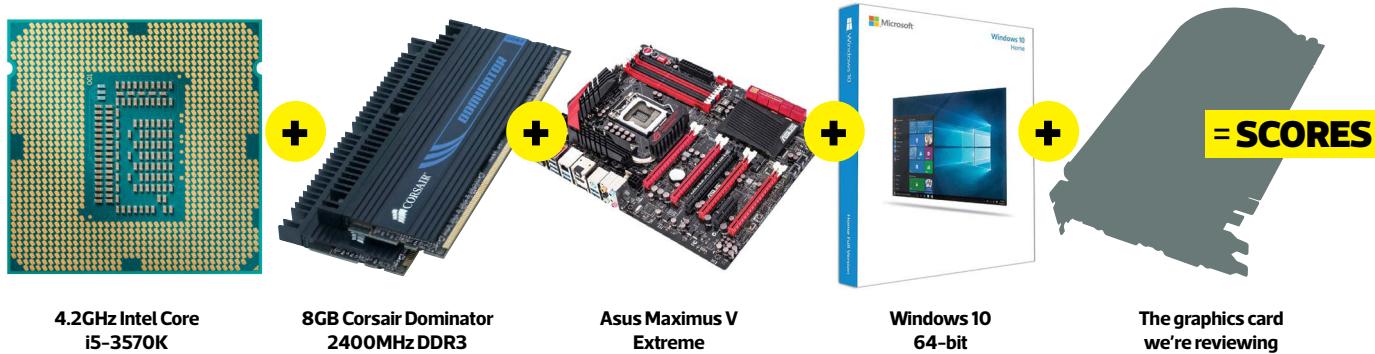
AMD Radeon R9 390X*
Windows 10 64-bit

TESTS: We use Custom PC RealBench 2015, Cinebench R11.5 and a variety of games. We also test the power draw of the test PC with the CPU installed. These tests reveal a broad range of performance characteristics, from image editing to gaming and video encoding to 3D rendering. We run all tests at stock speed and again when overclocked to its highest frequency.

*Please note: We test AMD FM2+ APUs using the on-board graphics, not the AMD Radeon R9 390X

GRAPHICS CARDS

Graphics cards are mainly evaluated on how fast they are for their price. However, we also consider the efficacy and quietness of the cooler. Every graphics card is tested in the same PC, so all results are directly comparable.



4.2GHz Intel Core i5-3570K

8GB Corsair Dominator 2400MHz DDR3

Asus Maximus V Extreme

Windows 10 64-bit

The graphics card we're reviewing

= SCORES

CUSTOM PC REALBENCH 2015

INTEL REFERENCE



AMD REFERENCE

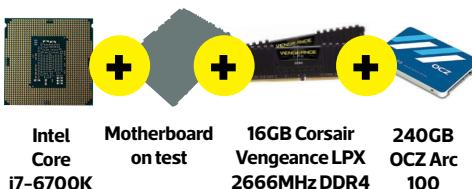


Our benchmark suite, co-developed with Asus, simulates how people really use PCs – a higher score is better. You can download them from www.asus.com/campaign/Realbench

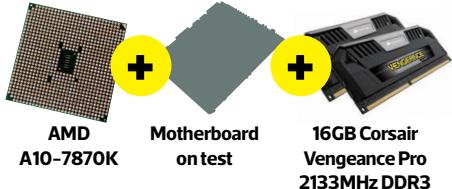
MOTHERBOARDS

Motherboards are evaluated on everything from layout and features to overclockability and value for money. Every motherboard is tested with the same components, so all results are directly comparable.

INTEL LGA1151



AMD FM2+



INTEL LGA2011-V3



COMMON COMPONENTS



TESTS: We use Custom PC RealBench 2015 and Total War: Attila, and also test the speeds of the board's SATA and M.2 ports. We try to overclock every motherboard we review by testing for a maximum QPI, base clock or HTT as well as overclocking the CPU to its maximum air-cooled level. We run our tests at stock speed and with the CPU overclocked.

*Please note: We test AMD FM2+ motherboards using the on-board graphics, not the AMD Radeon R9 390X

The Awards



EXTREME ULTRA

Some products are gloriously over the top. These items of excellent overkill earn our Extreme Ultra award.



PREMIUM GRADE

Premium Grade products are utterly desirable – we'd eat nothing but beans until we could afford them.



PROFESSIONAL

Products worthy of the Professional award make you and your business appear even more awesome.



APPROVED

Approved products are those that do a great job for the money; they're the canny purchase for a great PC.



CUSTOM KIT

For those gadgets and gizmos that really impress us, or that we can't live without, there's the Custom Kit award.



TESTS: By using the fast PC detailed on the left, we can be sure that any limitations are due to the graphics card on test, rather than being CPU limited. We test GTA V, Shadow of Mordor, Crysis 3, Fallout 4 and The Witcher III: Wild Hunt at their maximum detail settings, in their highest DirectX mode, at several resolutions. High-end cards should be able to sustain playable frame rates at 2,560 x 1,440, while 1,920 x 1,080 is more important for mid-range cards; we also test at 3,840 x 2,160 for 4K monitors, and try to overclock every graphics card we test to assess the performance impact.

Gaming on the go

Gaming laptops are more efficient than ever, so you don't have to settle for a big hulking laptop – we review eight models that elegantly merge speed and portability

The term gaming laptop can conjure up negative images of big, bulky machines that run excessively hot and loud and are too heavy to carry. For desktop replacements, such systems serve their purpose well enough, but anyone looking for decent gaming grunt in a chassis small and light enough to transport with relative ease has traditionally had to compromise.

However, times are changing. Intel's Skylake CPU architecture and Nvidia's Maxwell GPU architecture both offer considerable efficiency. The result is higher performance at lower power levels, which means less heat, so you can cool components with less metal

and in tighter spaces too. As a result, we're now seeing laptops that, while still being a stretch from Ultrabook dimensions, can be easily carried, yet still offer solid frame rates in modern games.

We've rounded up a selection of eight laptops from competing manufacturers and put them through their paces. While the core specifications are largely similar, there are considerable differences in size, weight, thermal design, build quality and price. We'll also be looking at a few related technologies, such as Nvidia's Battery Boost, the mobile implementation of G-Sync and external GPU housings.

MATTHEW LAMBERT

Featured this issue

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MSI GS40 6QE Phantom / p44

PC Specialist Defiance II / p46

Scan3XS LG15 Vengeance G-Sync / p51

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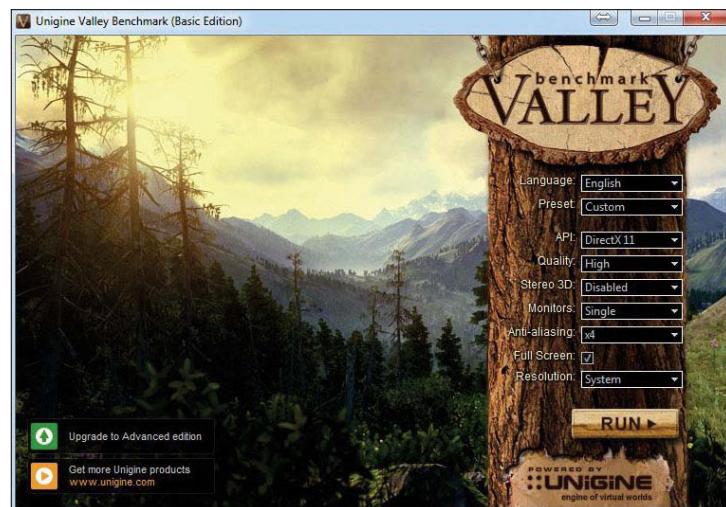
How we test

We first assess a gaming laptop physically, looking at its size and weight, the chassis' build quality, the usability of the touchpad, keyboard and ports, and the ease with which you can get into the laptop to upgrade or service it.

After letting the OS fully update and installing the latest graphics drivers, we assess overall system performance with our own RealBench software, which performs image editing, video encoding, OpenCL and heavy multi-tasking workloads, giving a score for each test based on time taken, as well as a weighted overall score. The test is looped three times and we report the average results. This test is run using the Balanced power setting in Windows while plugged into the mains.

To test gaming performance, we switch to the High Performance power mode, as well as the highest performance setting in any software bundled with the laptop. Using Fraps, we record the average and minimum frame rates in our Fallout 4, The Witcher 3 and Total War: Attila benchmarks, all at 1,920 x 1,080. The first two games punish the GPU, while the latter is also reliant on good CPU performance. We also run Fallout 4 and The Witcher 3 at the laptop's native resolution if it happens to be higher than 1,920 x 1,080. All game tests are run three times to ensure consistency.

Battery life is another very important factor, and first assess an intensive gaming scenario by firstly dropping back to the Balanced power setting and 50 per cent screen brightness. We then loop the Unigine Valley benchmark, recording how long the battery life takes to go from 100 per cent to 5 per cent; the standard critical battery level in Windows at which a system



To assess gaming battery life, we loop the Unigine Valley benchmark, recording how long the battery takes to go from 100 per cent to 5 per cent



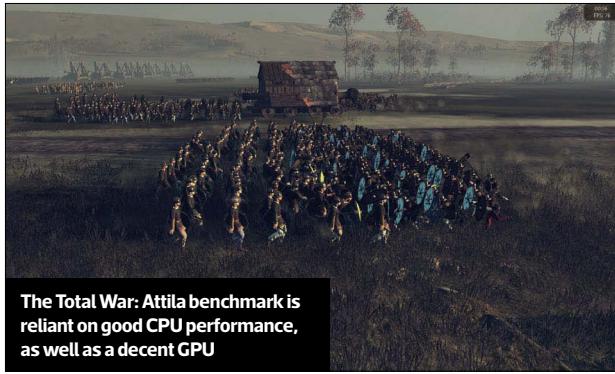
Our standard Fallout 4 and The Witcher 3 benchmarks punish the GPU hard

hibernates. Nvidia Battery Boost settings are left at their defaults, but we disable the Windows Battery Saver mode.

For a best-case scenario, we also drop to the Power Saver setting, leaving Battery Saver enabled in Windows. We then set the screen to minimum brightness and run PCMark 8's Work benchmark in battery mode, which loops basic workloads such as web browsing, spreadsheets, word processing and video chat until it can estimate a total battery life for such usage.

Next up is screen performance. Using an X-Rite i1Display Pro colorimeter and the open source DisplayCAL software, we assess the display's colour temperature and gamma, looking for ideal values of 6,504K and 2.2 respectively. We also look at the contrast ratio, as well as colour accuracy through average delta E results. Lastly, we perform a luminance uniformity test. All of these tests are run with the display at full brightness.

Finally, we assess the cooling system.



The Total War: Attila benchmark is reliant on good CPU performance, as well as a decent GPU

Watching a 1080p movie, we expect absolute or near silence. We then test whether the CPU throttles under heavy load by running Prime95. Finally, we loop Unigine Valley for ten minutes (enough time to reach a plateau), after which we can see whether the GPU is throttling and assess fan noise. We're only able to give subjective noise assessments due to the excessive and variable ambient noise in our central London lab. These tests are run with the laptop plugged into the mains and set to High Performance mode.

Each laptop is scored on four fronts. Speed accounts for 30 per cent, and is based on the laptop's raw speed in RealBench and game benchmarks. Design is equally important, accounting for size, weight, build quality, screen performance, battery life and thermal design. The Features component is worth 25 per cent, and considers factors such as the available ports, expansion slots, as well as features such as G-Sync and touch-screen support. Lastly, there's Value at 15 per cent, which is based on the scores elsewhere divided by the price. Most laptops have a few configuration options that can dramatically affect the cost, so we don't want to give this score too much importance.

Aorus X3 Plus v5 / £1,860 inc VAT

SUPPLIER www.occlockers.co.uk

With a price that's just shy of £1,900 inc VAT, the Aorus is the most expensive laptop on test, but it's easy to see why. The black, all-aluminium chassis is simply lovely both in look and feel, with the subtle angles and aggressive vent design adding to its charm. It also just pips the MSI to being the lightest model, it's the least wide and its thickness measures less than 23mm – it's truly a lean, mean gaming machine.

The Ethernet port and power input are the only rear-mounted connections, with all the others, including the power button, easily accessible at the sides. These connections include both USB 3.1 Type-C and HDMI 2, with a decent selection of other ports to satisfy most needs.

Meanwhile, the smooth touchpad is very pleasant to use and its two buttons are textured and not touch-sensitive, so you're unlikely to activate them accidentally. Similarly, the keys have a pleasant, springy action and, as laptop keyboards go, it's up there with the best. It features a white backlight with two brightness levels and, uniquely in this test, five macro keys. With five profiles too, there's lots of customisation on offer using the relatively simple software. The rounded-off edges ensure the X3 Plus v5 is comfortable to use too.

The Aorus also uses an IGZO-TFT (indium gallium zinc oxide) display with a massive resolution of 3,200 x 1,800. Since it only measures 13.9in across, you get an extremely high pixel density and a very crisp image. On the plus side, it's great for photo viewing and editing, and the image quality is great, with deep blacks resulting in one of the best measured contrast ratios. Other results here are strong too, with the brightness uniformity being the best of the bunch, and viewing angles are decent as well.

However, we can't help feeling that a 1,920 x 1,080 panel would be better with this G-Sync machine. It's a gaming laptop after all, and many powerful desktop GPUs would struggle with this native resolution, let alone the GTX 970M. As expected, the GTX 970M 6GB churns out solid, playable frame rates in all our games at 1080p, but performance crumbles at the native resolution.



Measuring less than 23mm thick, it's truly a lean, mean gaming machine

RealBench performance is generally a little slow compared with other laptops on test, but the laptop with the fastest overall score is still less than 5 per cent ahead of the Aorus, so the differences are pretty marginal, which isn't surprising given that every laptop on test uses the same CPU.

Still, we expected more given that, although the CPU did get very toasty under sustained load, it never dropped below the maximum turbo frequency in Prime95.

The cooler design also ensures that all heat is evacuated out the rear. It's efficient too.

preventing the CPU and GPU from throttling. Along with the MSI, the Aorus is one of the loudest models on test, but not obnoxiously so, and Aorus offers fan control software too. Importantly, it's virtually silent in light and idle tasks.

For storage, the 512GB SM951 strikes a strong balance between capacity and speed. There's no room for a 2.5in device, so capacity is important here, although there's a second, unused M.2 slot. Finally, the gaming battery life of just over an hour isn't terrible but it's not outstanding either. The Aorus also lasted almost five hours under our lighter workload, which is respectable.

Conclusion

The Aorus' premium price tag is matched by premium components such as the SSD and display. The chassis is fantastic, enabling Aorus to make very efficient use of space and keeping the weight below 2kg. It doesn't offer amazing value for money, but if you have the money, it's a great quality laptop.

SPEED 25/30	DESIGN 28/30	OVERALL SCORE 83%
FEATURES 21/25	VALUE 9/15	

VERDICT

Very pricey, but the Aorus is a seriously great quality laptop, with a strong focus on keeping size and weight as low as possible without sacrificing features or performance.



Asus Zenbook Pro UX501VW / £1,487 inc VAT

SUPPLIER www.scan.co.uk

Like the Aorus (opposite), Asus' UX501VW is very well crafted. The sleek and stylish all-metal exterior has at least a whiff of Apple about it, which is no bad thing when it comes to laptop design. The width and depth are mainly dictated by its 15.6in screen; it's very slim at 21.3mm and it's also the lightest laptop in this class on test, weighing in at under 2.3kg.

A consequence of the size is a very large area for supporting your wrists when typing, and it's comfortable to rest against the slightly textured metal. Meanwhile, the large touchpad is a single body model with a glass-coating and touch-sensitive buttons, which all works fine, although the key action on the backlit keyboard feels a little spongy.

All the ports are neatly located on the sides, with a healthy selection of USB ports that includes a USB 3.1 Type-C port with Thunderbolt capabilities. One notably lacking feature is an Ethernet port, but Asus sensibly provides a USB to Ethernet adaptor. Also, the HDMI version is 1.4, not 2, so this laptop isn't ideal for hooking up to a 4K TV.

Another similarity to the Aorus is that the Asus' screen is a big selling point. Its 3,840 x 2,160 resolution results in pin-sharp images and text, and it's also a touch-screen – a feature that's unique in this test. The screen is very bright, although it has a pretty poor contrast ratio measurement of just 360:1. Still, colour accuracy is very good, even if the whitepoint leaves the image a little on the cool side.

For storage, we again can draw parallels with the Aorus, with Asus opting for the same 512GB Samsung SM951 NVMe SSD. This drive gets you good capacity and massive speed with minimal footprint, which is just as well, as there's no room for any other drives in this machine.

While the physical design impresses, though, the performance here is underwhelming. The UX501VW places bottom in every RealBench measurement, and it's the only laptop to show significant performance differences from the other machines on test. It has the same Core i7-6700HQ CPU as the others, but the unequal RAM allocation (1x 8GB, 1x 4GB) may be to blame. We also observed the CPU



It's the lightest laptop in this class on test, weighing under 2.3kg

frequency cutting back a little from the maximum turbo speed under sustained load, but not to an alarming degree.

Similarly, GPU performance is disappointing. The GTX 960M 2GB isn't able to provide playable frame rates in any of our tests, so even at 1080p, you'll need to make a number of detail sacrifices.

Pleasingly, the Asus is at least a very quiet machine. It's inaudible in low-load situations, and it's even reasonably quiet when gaming. That said, we did observe the GPU gradually reducing its clock speed under load, eventually settling at around 915MHz. This behaviour isn't especially surprising – there

are only very small vents at the rear and bottom so as to not spoil the sleek looks. Thankfully, the metal chassis doesn't become uncomfortably hot as a result.

Much of the limited space has also been reserved for the battery – the UX501VW has the highest-capacity battery of any other laptop on test. Paired with the low power requirements of the GTX 960M, the gaming battery life clears two hours, although your detail settings will need to be very low. The PCMark 8 result is ridiculously long too, at almost nine hours.

Conclusion

For a 15.6in laptop, Asus has done a standout job matching our thin and light criteria, and the battery life is great. With only a GTX 960M 2GB in tow, however, the gaming credentials are lacking, especially for the price tag.

Unless your gaming needs are more a passing afterthought when buying a laptop, there are plenty of more suitable choices in this Labs test.

SPEED 18/30	DESIGN 28/30	OVERALL SCORE 77%
FEATURES 21/25	VALUE 10/15	

VERDICT

A great design and long battery life, but at this price, it's outclassed by the competition when it comes to gaming.



Cyberpower Fangbook 4 SX6-200 / £999 inc VAT

SUPPLIER www.cyberpowersystem.co.uk

The Fangbook 4 SX6-200 is presented in a fairly bulky, 27mm thick chassis, and it isn't as strong as some of its competitors either, showing too much flex in a few places. Still, it has a mostly metal exterior, which is preferable to plastic, but the finish is slightly glossy and shows marks too easily. There's also quite a thick bezel around the screen, but the mechanism for moving this screen is solid.

The touchpad is generally fine to use and has clicker buttons that are totally separate from it, although they're made from plastic and sound quite loud when depressed. On the plus side, the full-sized keyboard doesn't present any issues, and it has a few special features, including a couple of user-definable keys that can be set as shortcuts to programs or files of your choosing, and RGB backlighting with software to manage it. This software divides the keyboard into three programmable sections, and the basic effects on offer are pretty good, including moving and breathing effects with smooth transitions.

Meanwhile, the display is your standard 1080p affair. While the contrast ratio was impressively bang on 1,000:1, the remaining results were less than impressive, with colour accuracy, colour temperature and gamma all at the bottom of the pile in this test, and display uniformity being second worst. None of the results was terrible, but they're areas where the competition has an upper hand.

You get good connection options, though, with audio, video and USB ports all in abundance. The set of ports includes USB 3.1 Type-C, and they're all sensibly located on one of the two side sections.

Sadly, however, performance is another area where the Fangbook 4 SX6-200 is a bit of a letdown. It only has a GTX 960M to drive games, and consequently, only the Asus UX501VW has slower gaming results, with the Cyberpower only managing to scrape one playable result out of our three games – be prepared to play at lower-detail settings with this laptop. RealBench performance was reasonable too, which is to be expected, as this laptop features the same Intel Core i7-6700HQ and 16GB of DDR4 memory as most of the other laptops on test.

Storage is another area where the Cyberpower struggles though. While the Samsung SM951's PCI-E 3 and NVMe credentials lend it speed, the company has



It has a mostly metal exterior, which is preferable to plastic

limited itself to the 128GB model to meet the sub-£1,000 price. Even with our three test games installed, we pushed the limits of this capacity. The system does have a 1TB hard drive (and a DVD writer), but you ideally want your OS and all your games on solid state storage, which this setup will make tricky.

We also hoped that the relatively large chassis and low-power GPU would result in a very quiet experience, but sadly, we were mistaken. The case has intake vents at the front and on the bottom, with exhausts at the rear, but we still heard the fans kicking off, albeit briefly, even when the laptop was idle or under minimal load. Granted, it was quieter than most machines under gaming

workloads, but the fans take a while to ramp back down to near-silent levels once you finish playing. Also, while the GPU remained unthrottled, the CPU dropped below its base frequency at heavy load, a clear and unfortunate sign of throttling. The wrist rest area also becomes a little warm and clammy after prolonged use.

In addition, the Fangbook has one of the lowest-capacity batteries on test and it shows. In a gaming workload, it manages less than one hour, despite only having a GTX 960M. Even with the light workload, it only just managed to surpass 2.5 hours.

Conclusion

The Cyberpower's sub-£1,000 price tag might be attractive, but it compromises in too many areas. When PC Specialist's offering (see p46) is smaller and lighter, while also sporting a faster GPU and more SSD space, there's just no contest.

SPEED 20/30	DESIGN 22/30	OVERALL SCORE 72%
FEATURES 17/25	VALUE 13/15	

VERDICT

A tempting price, but you can get a smaller, faster and better-balanced laptop for the same money elsewhere.

Gigabyte P35X v5 / £1,700 inc VAT

SUPPLIER www.occlockers.co.uk

Measuring less than 21mm thick, Gigabyte's P35X v5 is the thinnest laptop in this group test, and it only weights around 2.5kg as well. The smooth metal chassis is prone to picking up marks from grubby hands, but it's at least comfortable to rest on, in part because of the smooth edges. The bezel around the 15.6in screen is rather large, but aesthetically, the P35X v5 is fine, if a little plain. It feels strong, has a sturdy screen adjustment mechanism and grips surfaces well.

Meanwhile, the single-body touchpad has touch-sensitive buttons, which are a little stiff. The keyboard, however, has a quiet key action and doesn't feel too sticky or spongy either. Via the FN key, you also get on-board media controls and two levels of brightness for the white backlight. The P35X v5 has some of the best connection options on test too, with a trio of USB 3 ports, USB 3.1 Type-C support and video outputs to cover all needs, including HDMI 2. None of these ports is located at the rear either, so finding them is easy.

There's a powerful specification under the hood as well – the Core i7-6700HQ CPU and 16GB of DDR4 memory are joined by an Nvidia GTX 980M GPU and 256GB Samsung SM951 NVMe SSD. That said, it's the same underlying spec as the Scan system, which is over £200 cheaper. For additional storage, you get a 1TB hard drive and Gigabyte has even managed to fit an optical drive inside this chassis, along with a 2.5in adaptor to fit another SSD or hard drive in the optical drive bay should you wish.

Another small bonus with this chassis is the single-screw slot cover for the dual memory modules, paving the way for easy upgrades or replacements. There's also a secondary M.2 slot available, but access requires removal of the full bottom cover.

System performance is strong too – the Gigabyte produced the third highest RealBench overall score on test, but again, the differences are small. The gaming results are good as well – the P35X v5 is way ahead of GTX 970M models in Fallout 4 and The Witcher 3, although Scan's laptop is faster, particularly in Total War. The Gigabyte's latter result is probably explained by throttling – the



Gigabyte has even managed to fit an optical drive inside

CPU and GPU temperatures were the highest on test in stress testing, and both chips' frequencies were limited as a result – only a little, but enough to make a difference in Total War, which is reliant on both the CPU and GPU.

While the cooling system is, of course, audible under load, the noise isn't obnoxious or the loudest on test. Given the hardware it has to cool, it's pretty efficient, and any heat is healthily blasted out the back too. Gigabyte could have ramped up the fan speeds to increase cooling and eliminate throttling, but the default setup strikes a good balance. The main problem, however, is that you can still

hear the fan whirring away if the machine is idle or under low load.

The lack of G-Sync is also a shame at this price, especially given its presence on Scan's machine. The 1080p panel's performance is a mixed bag too – the contrast ratio is excellent, while gamma and colour temperature are close to optimum values, but the uniformity and delta E results were comparatively disappointing. On the plus side, in spite of its size, the P35X v5 has the second highest battery capacity on test, netting it almost 90 minutes of mobile gaming time – a fine result.

Conclusion

The Gigabyte impresses in many regards. The chassis is thinner, lighter and better built than that of the Scan, but you sacrifice some performance.

More importantly, the lack of G-Sync and the significantly higher price tag means the Scan just nabs a victory on balance. However, if getting a thin and light gaming machine is an absolute priority, the Gigabyte remains a fine, albeit costly, alternative.

SPEED 28/30	DESIGN 26/30	OVERALL SCORE 82%
FEATURES 19/25	VALUE 9/15	

VERDICT

Almost award-winning, but held back by its high price and lack of G-Sync in the face of stiff competition.



MSI GS40 6QE Phantom / £1,300 inc VAT

SUPPLIER www.occlockers.co.uk

The GS40's 14in screen definitely helps with its portability. It has a very similar weight and thickness to the Aorus, but the latter isn't as wide and the MSI is less deep. The MSI's brushed-metal chassis looks and feels pleasant, although it smudges easily. The build quality isn't quite as good as that of the Aorus' but it's very good nonetheless – there are no issues with the screen movement mechanics either, and the laptop has plenty of grip.

The core specification, including the CPU, GPU and RAM, is also the same as that of the Aorus machine. The main difference between the two systems is storage. The MSI has a 256GB NVMe SSD with a 1TB 2.5in hard drive, compared with the single 512GB NVMe SSD in the Aorus.

While the MSI has more capacity, there's less speedy SSD storage for storing your games. The use of a hard drive also takes up room that could be used for extra airflow in the chassis, or to install a higher-capacity battery. That said, there isn't much difference in battery life – the GS40 still manages over an hour when gaming and close to five hours under low load, which is good going.

Meanwhile, the MSI's entire touchpad area is touch-sensitive, including the buttons, which have no delineation between them. The buttons themselves have a low travel and feel a little mushy and imprecise. Thankfully, however, the MSI's keyboard is one of the best examples on test, offering crisp and clean feedback. You also get two brightness levels for the red backlight. You also get a standard 1080p panel with the GS40 6QE Phantom, and most results of its colorimeter results are fine, although contrast is a little on the low side.

The Aorus provides another convenient comparison point for connections – the two laptops are largely the same in this respect, including the fact that the GS40 doesn't quite manage to contain all the ports to the side sections. To its credit, the MSI supports Thunderbolt 3 through its USB 3.1 Type-C connector, but to its detriment, it only supports HDMI 1.4 rather than 2.

In terms of performance, comparatively, the MSI's RealBench results a little slow, but not to a degree that should cause concern. The Fallout 4 and The Witcher 3 results are



The MSI's brushed-metal chassis looks and feels pleasant

good too, but the GS40 slips up in Total War: Attila, with a significantly lower frame rate than the other GTX 970M laptops. This result puzzled us at first; in the individual CPU and GPU stress tests, we didn't see any throttling. However, the results were consistent across multiple tests. This game puts heavy stress on both components, which probably causes the CPU frequency to hold back a little as the cooling system is overloaded.

There are other niggles with the cooling system too. For starters, it's too noisy when idle or under low load, with the fan occasionally having to spin up, which is pretty distracting when watching a movie, for example. Also, not all the heat is directed out

the rear – some comes out the right side. Admittedly, this exhaust area is positioned towards the back, but it can still irritate your hand if you're playing with a mouse. Under load, it's one of the noisier models on test too, just like the Aorus, which isn't surprising given the combination of powerful components and a small chassis.

Conclusion

Of the 14in models on test, the MSI falls in between the PC Specialist and the Aorus in terms of price. It's actually a pretty good laptop, but a few issues with performance and the cooling system means it doesn't do enough to justify its 1.3x price premium over the very well-priced Defiance II, while the Aorus, with its high-resolution screen, macro keys, better made chassis and improved cooling system (especially when idle) makes it more attractive, even with the premium pricing.

SPEED 25/30	DESIGN 26/30	OVERALL SCORE 79%
FEATURES 17/25	VALUE 11/15	

VERDICT

Impressively thin and light, and a decent laptop in many respects, but a few issues with performance and its cooling system means it can't quite justify its price.



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Now SLIMMER, LIGHTER & MORE POWERFUL

PC Specialist Defiance II / £999 inc VAT

SUPPLIER www.pc specialist.co.uk



The Defiance II is the joint least expensive laptop on test, but in this case you get a GTX 970M, whereas the Cyberpower only has a GTX 960M. While the Cyberpower has a fast NVMe SSD, though, PC Specialist's SSD only supports SATA 6Gbps. However, you get almost double the capacity (240GB vs 128GB), with both laptops also having a 1TB hard drive. At this price, PC Specialist's approach makes more sense – it will be hard to tell the two machines' speed apart in most 2D tasks, but the 128GB of storage in the Cyberpower will quickly limit you once a few games are installed.

The PC Specialist's Clevo-made chassis is also lovely, with a solid metal exterior that's smooth, comfortable and not too prone to accumulating fingerprints. Edges are rounded off, and while grip could be firmer, it won't slide around your desk. It looks smart too, if a little plain, and it's a bit heavier and thicker than the other two 14in laptops on test.

Meanwhile, the keys have a good action and offer a decent typing experience, along with a white backlight with five stages of brightness. Likewise, the touchpad buttons are pleasant to use, with a lightly cushioned action ensuring they don't make a nasty clacking noise. They're also separated from the touchpad's touch-sensitive area. There's an impressive set of media connections too, including an S/PDIF output and a second mini-DisplayPort socket, but HDMI 2 and USB 3.1 would arguably be more useful. The ports are at least all bound to the sides of the chassis – only the power connection is on the back.

In terms of speed, the Defiance II sits in the middle of the pack in RealBench, showing that its slower SSD isn't really a hindrance in real software. The gaming results are on par for a GTX 970M machine too, and the Defiance II also managed a great result in Total War: Attila, where others fell down, indicating effective cooling. In our stress tests, the CPU pulled back slightly from its peak turbo speeds as the temperature got quite high, but the GPU temperature was one of the coolest on test.

Like every other laptop on test, the fan noise is audible when the system is under load, but it isn't too loud. Importantly, it very quickly becomes inaudible once load is removed, and it won't bug you when you're



It got a great result in Total War: Attila, where others fell down

watching a movie or trying to work. All heat is shot out the back as well, and the area in front of the keyboard doesn't get too hot either, indicating a decent thermal design.

The 45Wh battery is the lowest on test, so the good cooling system would appear to be installed at the expense of battery life. However, the results tell a different story, as the Defiance II's battery still mostly keeps up with the competition. It's near the bottom of the charts when gaming, admittedly, but there are many laptops scrunched together in this

test with differences of just a few minutes, and the battery still lasted for over an hour. Meanwhile, the PCMark 8 test puts the battery life at over four hours, which again is far from the worst result on test.

Finally, the 1080p panel achieves a respectable set of results across the board, with the Defiance II also offering the closest to optimal colour temperature on test.

Conclusion

For under £1,000, the Defiance II is a brilliant laptop. You get a lot of bang for your buck and a sensibly selected storage system that balances cost, speed and capacity. The cooling system is also effective, and the battery and screen are decent too. It may not technically be the best 14in model on test, and it lacks a few features, but it strikes a great balance for the money.

SPEED	DESIGN	OVERALL SCORE
26/30	26/30	83%
FEATURES 16/25	VALUE 15/15	

VERDICT

A well-balanced system in a neatly presented chassis. It lacks a few features, but the performance is great for the money, making it our best buy for tight budgets.





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G-MASTER™
MONITORS 4 GAMERS

RED EAGLE™

GB2488HSU | GB2788HS

24" **27"** **144Hz** **Free Sync**

Panel	LED 1920 x 1080
Response time	1 ms, 144Hz, FreeSync™
Features	OverDrive, Black Tuner, Blue Light Reducer, Predefined and Custom Gaming Modes
Inputs	DisplayPort, HDMI, DVI
Audio	speakers and headphone connector
Height adjustment	13 cm



Nvidia Battery Boost

While conserving the battery life of one device or another is a daily thought for all of us these days, gaming laptops have always been especially prone to battery depletion. Even with the advances made in efficiency, today's GPUs are very power-hungry, particularly as games continue to push them harder.

All the laptops tested this month include Nvidia GTX 900M-series GPUs, meaning they feature Battery Boost technology. Nvidia first implemented Battery Boost in the GTX 800M series, and it can supposedly deliver up to a doubling of battery life while retaining playable performance. Battery Boost uses specific hardware built into GTX 800M series-GPUs and later, but also needs Nvidia's GeForce Experience (GFE) software to be installed to make use of software features and provide the user interface.

Traditionally, you get less performance from a laptop running on battery life than when it's plugged in, especially in games, as the power-saving tech will kick in. However, Battery Boost is a system-wide, intelligent means of distributing and saving what power is available, keeping performance only at the level needed to deliver a minimum acceptable frame rate. Nvidia is extremely vague about how the tech works, but it works in conjunction with Nvidia Optimus, which automatically switches between low-power integrated graphics and more demanding discrete graphics as needs dictate. Battery Boost kicks in automatically whenever you start gaming on battery power.

While Nvidia insists Battery Boost is more than just simple frame rate control, that's a large part of it, and GFE lets you specify a

maximum frame rate for games when running on battery – 30fps seems to be the typical default (and lowest available value). The basic idea is that the GPU only uses as much power as necessary to reach the desired target, rather than using close to full power constantly in order to render as quick as possible.

More demanding scenes and higher detail settings will ramp up usage and lower battery life, as the GPU has to work harder and longer to reach the target. Another element of GFE and Battery Boost is the ability to control detail settings for supported games on a per-game basis. You can have different settings for when your laptop is plugged in and on battery power, and Nvidia offers a one-click Optimize button. The settings won't just be the game's lowest available ones if you click this button – the Optimize feature considers your GPU's performance and aims to give you the best image quality possible. Resolution can be changed on a per-game basis, but the target frame rate is a global setting. Unlike the

frame rate control, On Battery detail settings naturally require a game restart to activate.

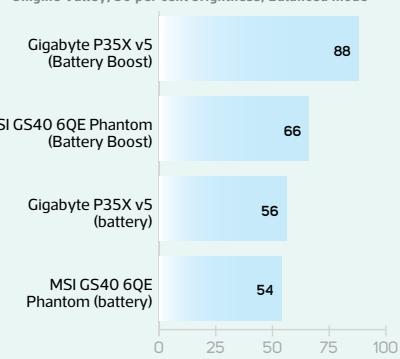
To test the impact of Battery Boost on performance and battery life, we ran some tests on the MSI GS40 6QE Phantom (GTX 970M) and Gigabyte P35X v5 (GTX 980M). Leaving the target at 30fps, we ran our Witcher 3 benchmark with our usual settings, and at the Medium and Low presets, when plugged in, on battery with Battery Boost and on battery with no Battery Boost. We also reran our battery life test with Unigine Valley, this time with Battery Boost disabled – the results in the standard tests are all with Battery Boost enabled.

On MSI's laptop, The Witcher 3 was simply too demanding to run on battery alone. Even on the game's lowest detail settings (at 1080p), it was unable to achieve playable frame rates, despite delivering a 60fps minimum in the same test when plugged into the mains. This situation made the target 30fps essentially meaningless – if you're not already hitting at least 30fps without Battery Boost, then there isn't much the technology can do.

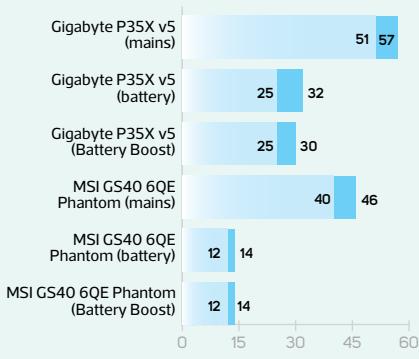
With Battery Boost disabled, the GS40 6QE dropped from 66 minutes of battery life to an even worse 54 minutes. Clearly, when a game is less demanding, as Unigine Valley is compared with The Witcher 3, savings can be made – Battery Boost still delivers a 22 per cent improvement in battery life in this test.

Gigabyte's GTX 980M laptop, however, shows Battery Boost working more clearly. Once again, there's a clear difference between running off the mains and battery. However, this laptop does maintain playable frame rates at every detail setting, even if

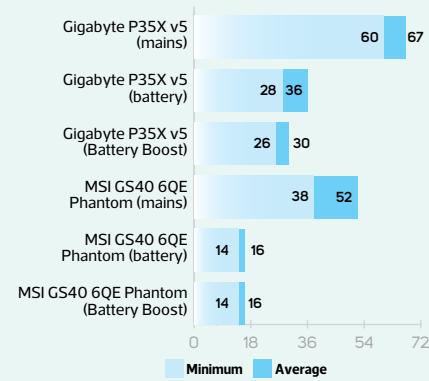
BATTERY LIFE – GAMING WORKLOAD (MINUTES)
Unigine Valley, 50 per cent brightness, Balanced mode



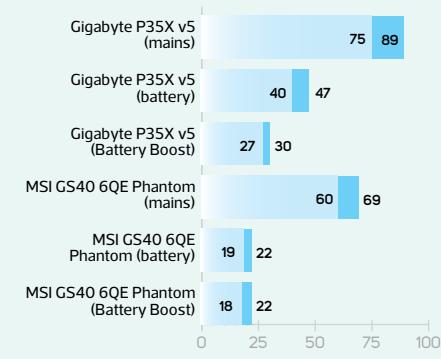
THE WITCHER 3: WILD HUNT
1,920 X 1,080 (FPS)
High Detail, Nvidia HairWorks off



THE WITCHER 3: WILD HUNT
1,920 X 1,080 (FPS)
Medium Detail, Nvidia HairWorks off



THE WITCHER 3: WILD HUNT
1,920 X 1,080 (FPS)
Low Detail, Nvidia HairWorks off





GeForce Experience lets you specify a maximum frame rate for games when running on battery – 30fps seems to be the typical default

only just. Enabling Battery Boost thankfully doesn't change this situation, and while the minimum frame rate does occasionally dip below the 30fps target, we were happy to see it never dropping below 25fps – the absolute minimum we consider playable. The average is always 30fps, so you still get a relatively smooth, constant frame rate while saving battery power in the process. Without Battery Boost, battery life when gaming on this machine drops to just 56 minutes, but that time multiples by over 1.5 to 88 minutes when it's enabled.

In summary, there are still many limits to achieving the goal of smooth frame rates when disconnected from the mains without

Setting	Plugged in	When on battery	Optimal
Ambient Occlusion	SSAO	Off	
Anti-aliasing	On	Off	
Bloom	On	Off	
Depth of Field	On	On	
Detail Level	High	Ultra	
Display Mode	Full-screen	Full-screen	
Foliage Visibility Range	High	Low	
Grass Density	High	High	
Light Shfts	On	Off	
Number of Background Characters	High	Ultra	
NVIDIA HairWorks	Off	Off	

You can have different detail settings for your laptop is plugged in and on battery power

either a massive battery pack or very low detail settings, but Battery Boost is a welcome step towards it, and it can be quite effective. The results here should only be taken as a rough guide, as it all depends on

the exact system and its battery capacity, as well as the game and detail settings you're using, but there's really no disadvantage to using Battery Boost when gaming on the move.

G-Sync goes mobile

Nvidia's G-Sync technology was first introduced in 2013, but only to desktop users, with compatible monitors requiring a large, power-hungry, proprietary scaler module. Large and power-hungry are two big red flags in the laptop industry, but in mid-2015 Nvidia announced G-Sync's availability for laptops anyway.

In case you need a refresher, G-Sync synchronises a display's refresh rate to the frame rate the GPU is outputting, ending screen tearing and minimising input lag – frames are only delivered in full and as soon as they're ready. The end result is buttery-smooth gameplay even when your frame rate varies and drops below 60fps.

G-Sync in laptops requires no proprietary hardware either. Instead, it uses the DisplayPort Adaptive-Sync feature in the

embedded DisplayPort standard, which allows the GPU to control the panel's refresh rate in the same way. The lack of proprietary hardware is very good news, as it means there should be no additional power costs.

The technology is only supported on the latest mobile Maxwell GPUs (GTX 965M, GTX 970M and GTX 980M, including SLI configurations). However, not just any laptop with these GPUs can use G-Sync, as it still requires qualification and certification from Nvidia.

The company requires this procedure to ensure a minimum panel quality, and also so that it can set specific profiles for the panels used in its drivers to achieve the best image quality, particularly with variable overdrive. This feature attempts to guess when the next frame will be delivered,

and set the overdrive value accordingly to reduce ghosting. There's a loss in colour accuracy as a result, but qualifying in this way helps to keep this problem to a minimum.

Sadly, there's a catch. Unlike Battery Boost, G-Sync doesn't work with Nvidia's Optimus technology, as the panel must be directly connected to the Nvidia GPU. This means the discrete GPU is engaged all the time, unlike with Optimus, where the CPU's integrated graphics system is used for less intensive tasks.

Nvidia's Maxwell architecture is efficient when idle, but not as efficient as integrated graphics, so there's likely to be a reduction in battery life on G-Sync laptops when performing simple web browsing and office work.

INDEPENDENT AND UNOFFICIAL GUIDE

MINECRAFT SECRETS & CHEATS

A central illustration of a Minecraft player character with brown hair, purple eyes, and a brown beard, wearing a light blue shirt and purple pants. He is holding a diamond sword in his right hand and a diamond pickaxe in his left hand. He is surrounded by floating brown, green, and orange cubes.

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Scan 3XS LG15 Vengeance G-Sync / £1,480 inc VAT

SUPPLIER www.scan.co.uk

Scan's LG15 Vengeance is presented in a big, Clevo-manufactured chassis. The main external surfaces (excluding the plastic underside) are metal, and resting on this material is comfortable, although it also smudges easily and the edges are a little sharp. This laptop is also both the heaviest and thickest machine on test, although it's still a far cry away from standard, beefier gaming laptops.

It's the screen that really makes this laptop shine though. It's another 1080p panel, but with one big difference – Nvidia's G-Sync tech, which is fantastic, eliminating tearing and stuttering artefacts from games. Frame rates between 30–60fps are pretty much standard for a gaming laptop at this price, which our results show very clearly, and this range is where G-Sync is most effective. It isn't a feature to be underestimated or understated; it makes a big difference to the visual quality of games, which you'll appreciate in every session. The screen holds up well in terms of image quality too, producing the best colour accuracy and gamma results on test.

There's a powerful selection of hardware as well, although nothing that isn't seen elsewhere on test. The Core i7-6700HQ CPU is accompanied by 16GB of DDR4 memory and a GeForce GTX 980M GPU. For storage, there's a 256GB Samsung NVMe SSD paired with a 1TB hard disk, with a second, spare M.2 slot inside the chassis.

Meanwhile, the Scan's connection options match those of the PC Specialist and XMG systems, both of which also use Clevo chassis. One of the four USB 3 ports is located at the back, which is no big deal since the rest, along with all the other ports, are side-mounted. The lack of HDMI 2 and USB 3.1 loses the Scan a few points, however. Then there's the smooth touchpad, which is joined by two separated buttons, although they feel cheap and plastic. Still, the action itself isn't too bad, and the keyboard is fine too. Like the other Clevo models, the Scan's keyboard also has five adjustable white backlight settings.

You really can't argue with the performance on offer from the Scan either. The overall RealBench result is the highest on test this month, and the same is true of all three games tests as well, where the closest rival, from Gigabyte, drops a few frames per second, as it can't boost its GPU frequency



G-Sync isn't a feature to be underestimated or understated

as far as the Scan. The Scan's GPU can't quite maintain peak frequencies all the time, but we only ever saw it dip by 30MHz or so.

The noise output when gaming isn't bad either – it's clearly audible but not excessively loud. However, while this laptop is quiet when idling, it's not inaudible, and the fans can be heard humming away in the background, which is unfortunate but not a deal-breaker. Nearly all the warm air is evacuated through the back, but some warm air is exhausted out of the back left side, which could potentially irritate left-handed gamers from time to time.

Finally, the battery life is okay at close to the 70-minute mark, although the Gigabyte's

battery lasted an extra 20 minutes, despite having the smaller and lighter chassis. The Scan put in a comparatively poor result in PCMark 8's battery test, though, barely scraping past two hours. This suggests that the use of Nvidia's Battery Boost tech (see p48) meant the Scan was still using the GTX 980M GPU under non-gaming workloads.

Conclusion

The Scan may be the biggest and weightiest laptop on test, but it still qualifies as thin and light relative to the massive size of so many gaming laptops. This size enables you to get a big 15.6in screen, plenty of power and even some upgrade potential. However, it's G-Sync that's the killer feature. This Labs test is very tight in terms of scores, but G-Sync, top performance and aggressive pricing sees Scan nab victory this month. That said, if you're pursuing portability to the max, there are some great 14in models on offer too.

SPEED	DESIGN	OVERALL SCORE
29/30	22/30	84%
FEATURES 22/25	VALUE 11/15	

VERDICT

The largest laptop on test, but it strikes a great balance of performance, design and features, and G-Sync really helps it to shine.

XMG P506 / £1,491 inc VAT

SUPPLIER www.mysn.co.uk

The chassis used by XMG is almost identical to that of the Scan, with Clevo being the OEM of both. This laptop is a fraction lighter, however, and also a few millimetres thinner, since it uses the GTX 970M version of the chassis.

Aside from the use of a GTX 970M GPU, though, this XMG configuration is basically the same price as Scan's laptop. You do get a 2TB hard drive and 2400MHz DDR4 memory instead of the usual 2133MHz RAM though. Also, the M.2 SSD is a Samsung SSD 950 Pro, which is technically a little better than the SM951 used by most others, although the real-world difference will be slight. However, it's the Scan's 980M that will make the biggest difference to gaming, so there's no denying that the Scan is the better value proposition.

Most of what we said about the Scan chassis applies here – the metal surfaces are comfortable but prone to smudging, and in certain areas, such as the touchpad buttons, it lacks finesse. The edges could be a little smoother for more comfortable typing as well, but nonetheless, the keyboard is effective and the white backlighting with five brightness levels is appreciated.

Likewise with the Scan, our only major issue with the port selection is the absence of USB 3.1 and HDMI 2. Meanwhile, removing the bottom cover reveals a spare M.2 slot and two spare RAM slots.

Again, as with the Scan, RealBench results from this Clevo setup were great, with the XMG coming second in the overall scoring. As expected, performance in games is also solid – the XMG never dipped below 30fps in any



Removing the bottom cover reveals a spare M.2 slot

of our test titles. It also didn't show any signs of throttling in Total War: Attila, a problem that plagued more than one of its competitors.

When running at full load, the XMG's cooling apparatus is able to dispel most heat through the rear vents – the left side does also shoot out a bit of warm air, although it's unlikely to bother many people. One benefit over the Scan is that the less powerful hardware in a similarly sized chassis means the cooling system has more headroom – we couldn't hear the XMG at all when it was idle or under mild load. With our gaming benchmark fired up, it also proved to be

quieter than the Scan. We didn't observe any throttling of either the CPU or GPU either, so while the XMG has a relatively big chassis for a 15.6in, GTX 970M-based laptop, the size has been put to good use.

G-Sync is also present, which is a sweet feature in a laptop, as it really smoothes out sub-60fps gameplay, eliminating tearing and stuttering artefacts. Interestingly, the panel results obtained with the colorimeter aren't as good as those from the Scan, but there are no major pitfalls here either – it just needs a little more contrast.



Finally, the P506's 80-minute gaming battery life places it third in this test, although the PCMark 8 battery test was worse than expected at under four hours. Still, in both instances, the XMG beats the Scan.

Conclusion

Given the similarities in chassis and the presence of G-Sync, the obvious comparison for this laptop is the Scan. Both machines can be configured differently, but this specific XMG build offers better battery life, lower noise levels and a slightly less bulky frame. The 2TB hard drive is also handy. However, with this laptop having nearly the same price as Scan, these advantages aren't quite enough to make up for the additional gaming prowess of the GTX 980M. There's little reason not to go for Scan's build given the price parity, or even select the Scan system with a GTX 970M if you want a slimmer, quieter chassis with better battery life.

SPEED 26/30	DESIGN 24/30	OVERALL SCORE 83%
FEATURES 23/25	VALUE 10/15	

VERDICT

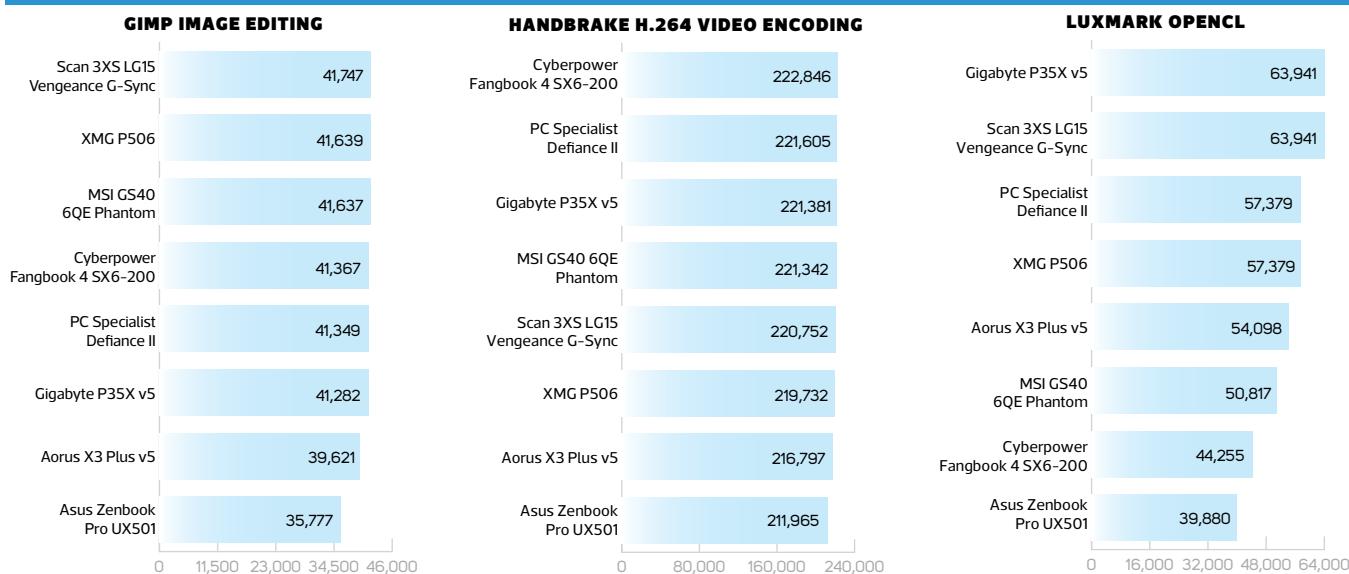
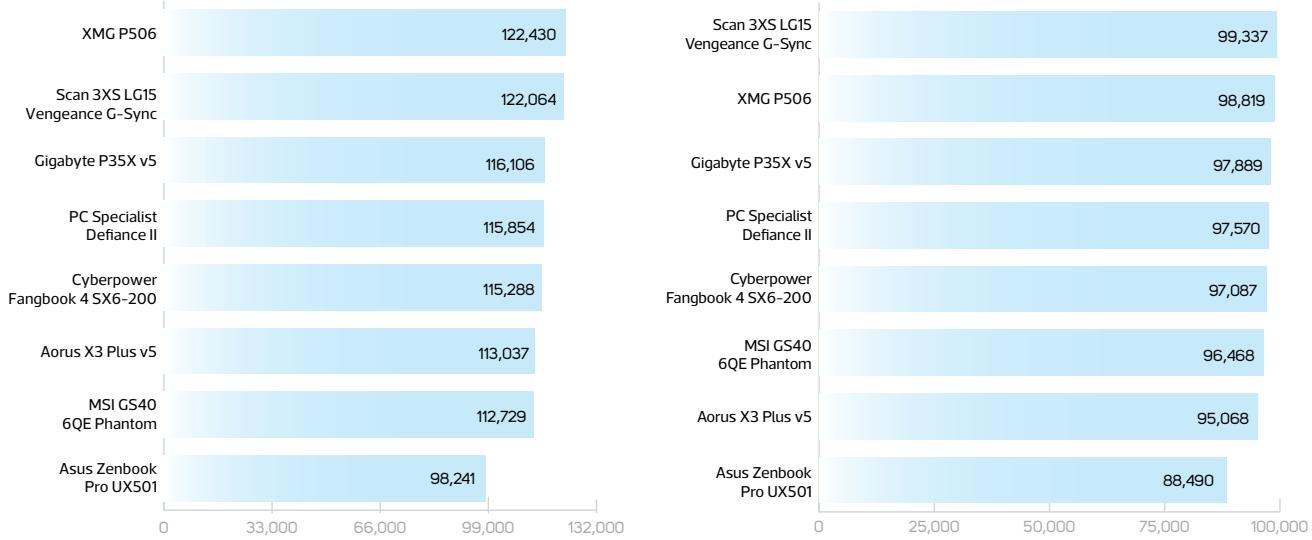
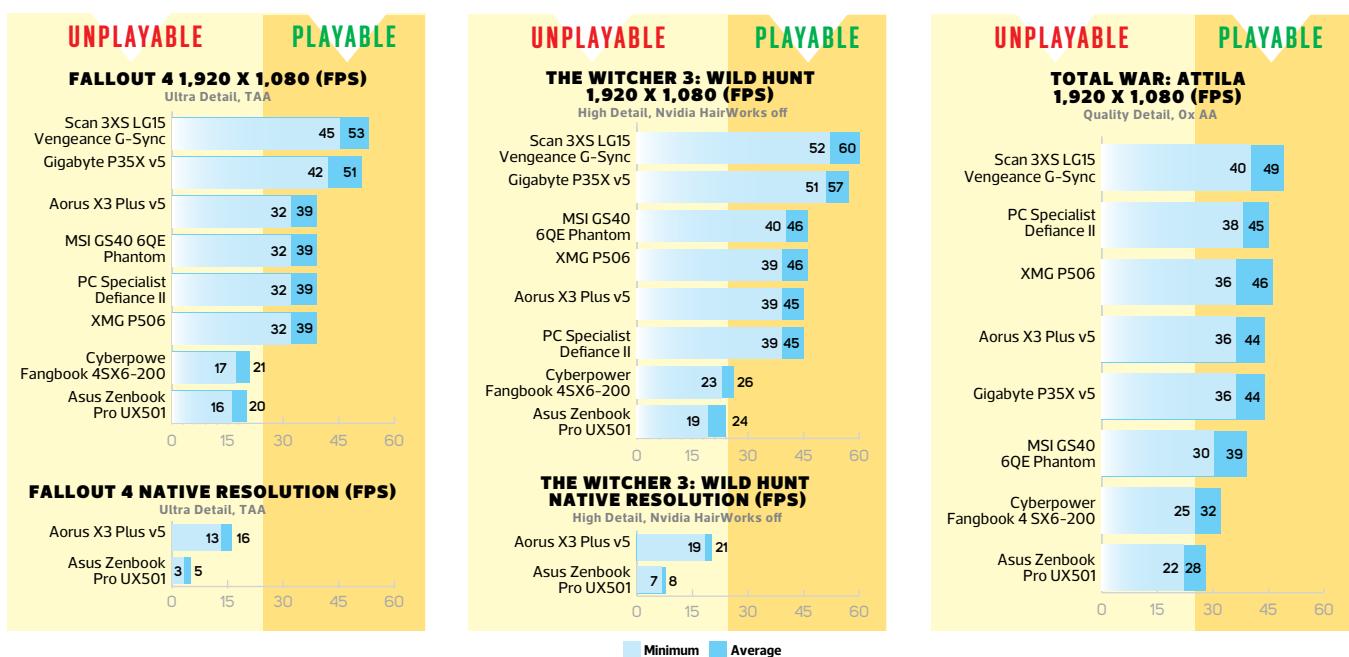
A decent gaming laptop with the bonus of G-Sync, although Scan offers a similar setup with a faster GPU for slightly less money.

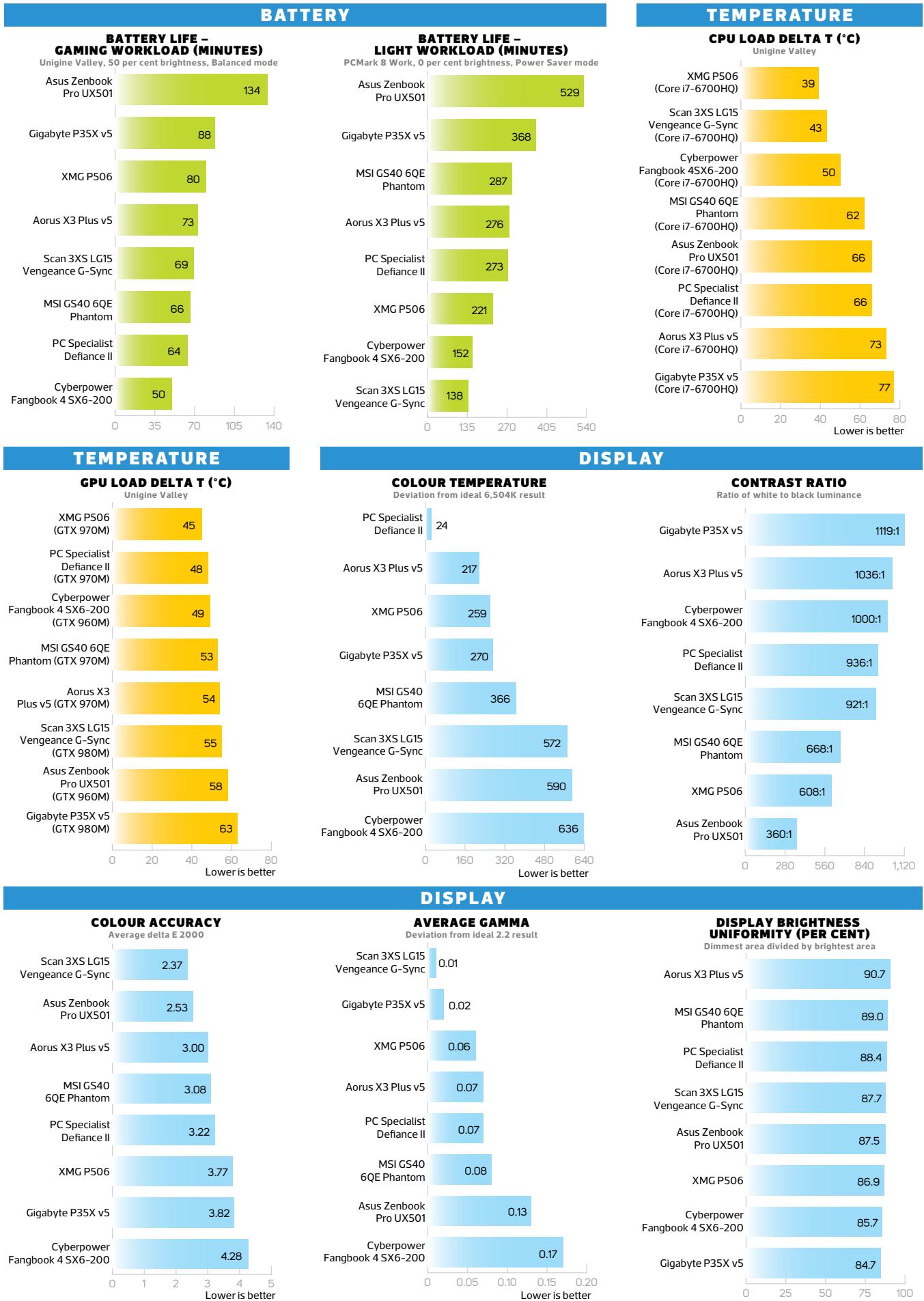
FEATURE TABLE

	AORUS X3 PLUS VS	ASUS ZENBOOK PRO UX501VW	CYBERPOWER FANGBOOK 4 SX6-200	GIGABYTE P35X V5	MSI GS40 6QE PHANTOM	PC SPECIALIST DEFIANCE II	SCAN 3XS LG15 VENGEANCE G-SYNC	XMG P506
Price inc VAT	£1,860	£1,487	£999	£1,700	£1,300	£999	£1,480	£1,491
Supplier	www.overclockers.co.uk	www.scan.co.uk	www.cyberpowersystem.co.uk	www.occlockers.co.uk	www.pc specialist.co.uk	www.scan.co.uk	www.scan.co.uk	www.mysyn.co.uk
COMPONENTS								
CPU	Intel Core i7-6700HQ, 2.6GHz	Intel Core i7-6700HQ, 2.6GHz	Intel Core i7-6700HQ, 2.6GHz	Intel Core i7-6700HQ, 2.6GHz	Intel Core i7-6700HQ, 2.6GHz	Intel Core i7-6700HQ, 2.6GHz	Intel Core i7-6700HQ, 2.6GHz	Intel Core i7-6700HQ, 2.6GHz
Memory	16GB (2x8GB) DDR4, 2133MHz	12GB (8GB on-board) 1x 4GB SODIMM) DDR4, 2133MHz	16GB (2x8GB) DDR4, 2133MHz	16GB (2x8GB) DDR4, 2133MHz	16GB (2x8GB) DDR4, 2133MHz	16GB (2x8GB) DDR4, 2133MHz	16GB (2x8GB) DDR4, 2133MHz	16GB (2x8GB) DDR4, 2400MHz
Graphics	Nvidia GTX 970M 6GB	Nvidia GTX 960M 2GB	Nvidia GTX 980M 8GB	Nvidia GTX 970M 3GB	Nvidia GTX 970M 3GB	Nvidia GTX 970M 3GB	Nvidia GTX 980M 8GB	Nvidia GTX 970M 6GB
SSD	512GB Samsung SM951 NVMe M.2, 4x PCI-E 3	512GB Samsung SM951 NVMe M.2, 4x PCI-E 3	128GB Samsung SM951 NVMe M.2, 4x PCI-E 3	256GB Samsung SM951 NVMe M.2, 4x PCI-E 3	256GB Samsung SM951 NVMe M.2, 4x PCI-E 3	240GB Kingston SSDNow M.2, SATA 6Gbps	256GB Samsung SM951 NVMe M.2, 4x PCI-E 3	256GB Samsung SSD 950 Pro NVMe M.2, 4x PCI-E 3
Hard drive	No	No	1TB, 5,400rpm, SATA 6Gbps	1TB, 7,200rpm, SATA 6Gbps	1TB, 7,200rpm, SATA 6Gbps	1TB, 5,400rpm, SATA 6Gbps	1TB, 7,200rpm, SATA 6Gbps	2TB, 5,400rpm, SATA 6Gbps
Optical drive	No	No	DVD-RW	DVD-RW	No	No	No	No
Wireless	802.11ac, Bluetooth 4.1	802.11ac, Bluetooth 4	802.11ac, Bluetooth 4	802.11ac, Bluetooth 4.1	802.11ac, Bluetooth 4.1	802.11ac, Bluetooth 4.1	802.11ac, Bluetooth 4.1	802.11ac, Bluetooth 4.1
Operating system	Windows 10 64-bit	Windows 10 64-bit	Windows 10 64-bit	Windows 10 64-bit	Windows 10 64-bit	Windows 10 64-bit	Windows 10 64-bit	Windows 10 64-bit
DISPLAY								
Screen size	13.9in	15.6in	15.6in	15.6in	14in	14in	15.6in	15.6in
Resolution	3,200x1,800	3,840x2,160	1,920x1,080	1,920x1,080	1,920x1,080	1,920x1,080	1,920x1,080	1,920x1,080
G-Sync	No	No	No	No	No	No	Yes	Yes
Touch-screen	No	Yes	No	No	No	No	No	No
PHYSICAL								
Weight	1.83kg	2.29kg	2.39kg	2.51kg	1.84kg	2.17kg	2.75kg	2.7kg
Dimensions (W x D x H) (mm)	330x263.5x229	383x255x213	383x260x27	385x270x20.9	345x245x22.8	349x247x25.4	385x271x28.8	385x271x25
Battery	LiPolymer, 73.26Wh	LiPolymer, 53Wh	LiPolymer, 75.81Wh	LiPolymer, 61Wh	LiPolymer, 45Wh	LiPolymer, 60Wh	LiPolymer, 60Wh	LiPolymer, 60Wh
Webcam	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SD card reader	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
USB	1x USB 3.1 Type-C, 2x USB 3, 1x USB 2	1x USB 3.1 Type-C, 2x USB 3, 1x USB 2	1x USB 3.1 Type-C, 2x USB 3	1x USB 3.1 Type-C, 2x USB 3	1x USB 3.1 Type-C, 2x USB 3	1x USB 3.1 Type-C, (Thunderbolt 3 supported), 2x USB 3, 1x USB 2	4x USB 3	4x USB 3
Video/Audio	1x HDMI 2.1x mini-DisplayPort, 1x headphone/microphone	1x HDMI 1.4, 1x headphone/microphone	1x HDMI 1.4, 1x mini-DisplayPort, 1x VGA, 1x microphone	1x HDMI 2.1x mini-DisplayPort, 1x headphone, 1x microphone	1x HDMI 1.4, 1x mini-DisplayPort, 1x headphone, 1x microphone	1x HDMI 1.4, 2x mini-DisplayPort, 1x headphones, 1x microphone, 1x S/PDIF out	1x HDMI 1.4, 2x mini-DisplayPort, 1x headphones, 1x microphone, 1x S/PDIF out	1x HDMI 1.4, 2x mini-DisplayPort, 1x headphones, 1x microphone, 1x S/PDIF out
Networking	1x Gigabit Ethernet	1x Gigabit Ethernet	1x Gigabit Ethernet	1x Gigabit Ethernet	1x Gigabit Ethernet	1x Gigabit Ethernet	1x Gigabit Ethernet	1x Gigabit Ethernet
Expansion	1x M.2 slot	No	No	No	No	No	1x M.2 slot	1x M.2 slot
Extras	Backlit keyboard, macro keys	Backlit keyboard, USB to Ethernet adapter	RGB Backlit keyboard	Backlit keyboard	Backlit keyboard	Backlit keyboard	Backlit keyboard	Backlit keyboard

*Prices correct at time of going to press



CUSTOM PC REALBENCH 2015

HEAVY MULTI-TASKING

GAMES




PC system reviews

GAMING PC

Computer Planet Manta / £1,673 inc VAT

SUPPLIER www.computerplanet.co.uk

Computer Planet's Manta is one of a growing number of mini-ITX machines that challenge full-sized rigs for performance, and this one comes inside NZXT's Manta chassis, which has an adventurous exterior. It isn't the small, boxy unit normally associated with mini-ITX – its panels, roof and rear are made with subtle curves that look great.

Computer Planet has opted for the black and red version of this case, so its soft, attractive metal panels are bordered with red plastic. There's a window on one side, a smart power button and no gaudy logos – it's a great-looking machine.

However, there's no denying that it's a little large for a mini-ITX rig. The Manta's bulging panels result in a 245mm width and 426mm height – dimensions we usually associate with micro-ATX builds or even smaller ATX cases. NZXT has used the bulk well, though, kitting out the Manta with a good selection of features.

The base is dominated by a sturdy metal shroud that hides a full-sized PSU and hard disk, and there's enough space at the front to accommodate a 280mm radiators without clashing with hefty graphics cards. There's space for two roof-mounted case fans and a 120mm exhaust as well. Cable management is more akin to larger cases too. The

Manta has a red, raised section that Computer Planet has used to hide most of the power cables, with the bottom shroud hiding the rest.

It all ensures a neat build, and Computer Planet has also done good work in continuing the Manta's black and red theme. It's fitted two Aerocool Dead Silent fans to the Corsair Hydro H110i v2 liquid-cooling unit and three more around the rest of the case. The Asus motherboard carries on the colour scheme, the graphics card has a two-toned heatsink and the Corsair memory is red too.

Of course, the mini-ITX form factor still has limitations. The motherboard has no free PCI-E or memory slots, there's no room for an extra hard disk, and the two 2.5in bays can't be properly used without the GPU and Corsair radiator being moved first. The M.2 slot that holds the boot drive is also on the back of the motherboard, which sits behind the motherboard tray, so access requires you to remove the motherboard entirely.

Thankfully, the Manta won't need extra components any time soon. The Core i7-6700K is a solid start, and Computer Planet



has overclocked its four Hyper-Threaded cores from 4GHz to 4.9GHz with a 1.39V vcore. That's a huge tweak, especially for a mini-ITX machine – even Scan's full-sized 3XS Z170 Vengeance Ti (see p58) only runs the same silicon at 4.7GHz.

Nvidia's GeForce GTX 980 Ti is another familiar high-end component, with 2,816 stream processors enabling 4K gaming on one GPU. The card deployed here is MSI's Gaming G6 variant, which has three overclocking profiles. Computer Planet has loaded the Gaming Mode, which boosts the 1000MHz GPU frequency to 1140MHz.

Elsewhere, there's a fast 256GB Samsung SM951 NVMe boot drive, a 2TB hard disk and 16GB of 3000MHz DDR4 memory. Meanwhile, the Asus Z170i Pro Gaming is an accomplished mini-ITX board. It offers SupremeFX audio and dual-band 802.11ac Wi-Fi, while the I/O panel has four USB 3 ports, USB 3.1 Type-A connectors, five audio jacks and an optical S/PDIF output. It's also great to see Corsair's RM750X PSU in this machine, offering 80 Plus Gold efficiency and fan-free operation under low loads.

Finally, you get a solid warranty, with a whole three years of collect and return cover for both parts and labour.

Performance

The huge CPU overclock helped the Computer Planet to deliver stunning application benchmark speeds. Its image editing score of 67,665 was around 300 points beyond the aforementioned full-sized Scan machine, and it extended this lead in our multi-threaded video encoding test, with a result of 346,183 – more than 10,000 points ahead of the 3XS rig.

/SPECIFICATIONS

CPU 4GHz Intel Core i7-6700K overclocked to 4.9GHz

Motherboard Asus Z170i Pro Gaming

Memory 16GB Corsair Vengeance LPX 3000MHz DDR4

Graphics MSI GeForce GTX 980 Ti 6GB

Storage 256GB Samsung SM951 M.2 SSD; 2TB hard disk

Case NZXT Manta

Cooling CPU: Corsair Hydro H100i GTX with 2x 120mm fans; GPU: 2x 90mm fans; rear: 1x 120mm fans; roof: 2x 120mm fans

PSU Corsair RM750X

Ports Front: 2x USB 3, 2x audio; rear: 4x USB 3, 2x USB 3.1 Type-A, 2x USB 2, 1x PS/2, 1x optical S/PDIF, 5x audio

Operating system Microsoft Windows 10 Home 64-bit

Warranty Three years parts and labour collect and return

- 1** The Core i7-6700K is overclocked to 4.9GHz
2 The MSI GTX 980 Ti card is set to run the GPU at 1140MHz
3 Two Aerocool Dead Silent fans are fitted to the Corsair H110i

The Manta fared well in our game tests too, with great results at 2,560 x 1,440 and a solidly playable minimum of 39fps in The Witcher 3 at 4K. Even Fallout 4 hit our borderline playable 25fps minimum target at 4K with Ultra settings – it will be even smoother at High settings. Only Crysis 3 failed our 4K playability test, but its minimum of 24fps will increase if you're prepared to tweak the settings.

The Manta's 3x PCI-E NVMe SSD offered amazing results too, with read and write speeds of 1,995MB/sec and 1,215MB/sec respectively. That's far quicker than the SATA drive in the aforementioned, similarly priced Scan PC.

The Computer Planet's smaller size hindered its thermal and aural performance, which isn't surprising when you consider the overclock. Its CPU delta T of 70°C matches the Scan, with both chips throttling back to 4GHz under heavy loads, and the Manta's GPU delta T of 60°C is pretty hot too. Both results are within thermal limits, but the Manta clearly has a hot interior. Not surprisingly, the Manta also gets noisy when stress tested, although the low rumble isn't irritating.

Conclusion

There's plenty to like about Computer Planet's Manta. It's rapid in applications and games, its mini-ITX case is well-made and smart, and Computer Planet has used consistent colours, while taking care over its build and component

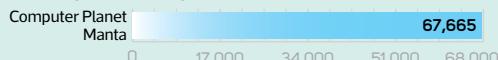


choices. It isn't perfect – it's a little large for a mini-ITX machine, while lacking the upgrade room of machines that are only slightly bigger, and it also gets hot inside. However, if you're looking for storming performance in a smallish, good-looking machine, the Manta delivers the goods.

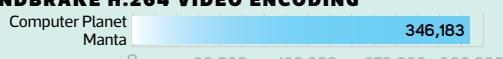
MIKE JENNINGS

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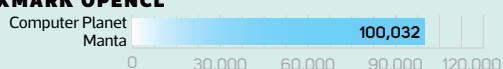
GIMP IMAGE EDITING



HANDBRAKE H.264 VIDEO ENCODING



LUXMARK OPENCCL



HEAVY MULTITASKING



SYSTEM SCORE



INTEL REFERENCE: 136.11%

SPEED
23/25

DESIGN
21/25

HARDWARE
22/25

VALUE
20/25

OVERALL SCORE
86%

FALLOUT 4

2,560 x 1,440, Ultra Detail, TAA



3,840 x 2,160, Ultra Detail, TAA



THE WITCHER 3

2,560 x 1,440, High Detail, AA on, HairWorks off



3,840 x 2,160, High Detail, AA on, HairWorks off



CRYYSIS 3

2,560 x 1,440, Very High Detail, Ox AA



3,840 x 2,160, Very High Detail, Ox AA



Minimum Average

VERDICT

A smart and good-looking mini-ITX machine with an amazing overclock and great performance, although it's big for a mini-ITX rig and it gets hot.

GAMING PC

Scan 3XS Z170 Vengeance Ti / £1,600 inc VAT

SUPPLIER www.scan.co.uk

Scan's latest 3XS Z170 Vengeance Ti is a high-end gaming PC that's been designed around the demands of the next big trend in gaming: VR headsets. Its spec has been deliberately designed to have the power to cope with the Oculus Rift and the HTC Vive. They're the two big names in PC VR right now, and they both have hefty system requirements.

As a bare minimum, these VR systems need a PC with Nvidia GeForce GTX 970 or AMD Radeon R9 290 graphics alongside a Core i5 CPU and 8GB of memory, but ideally, you want even more power. Outputting stereoscopic 3D video to two miniature screens is no mean feat. It's fair to say that Scan has gone beyond those minimum requirements, with a GTX 980 Ti GPU, Core i7 processor and 16GB of DDR4 RAM.

The graphics card certainly has the power to handle VR. The GTX 980 Ti sports 2,816 stream processors, and the EVGA model used by Scan increases the 1000MHz stock GPU

frequency to 1102MHz, with a 1190MHz boost clock.

Meanwhile, the familiar Core i7-6700K is overclocked to 4.7GHz, the 16GB of memory rattles along at 3000MHz, and there's a 500GB Samsung 850 Evo SSD and a 2TB storage drive. It's a shame there's no PCI-E NVMe SSD, but it's still great to have 500GB of solid state storage.

The Asus Z170 Pro Gaming is good too. Its dark design matches the rest of the machine, and it ticks every box: support for 64GB of DDR4, a spare M.2 socket, support for multi-GPU and a backplate stocked with USB 3 ports, USB 3.1 connectors and five audio jacks. It also features Asus' SupremeFX dedicated audio circuitry, and there's a row of customisable LEDs beneath the board's name as well. The Z170 Pro Gaming is only really missing enthusiast additions, such as on-board power and reset buttons.

It's a well-rounded specification, but the Scan's mid-range price means it faces competition from the likes of Overclockers' Titan Finesse Phoenix, which came in at £1,667 inc VAT, featuring similar silicon in a loud, extravagant design. In contrast, Scan has kept the 3XS Z170 Vengeance Ti smart and subtle. The motherboard, memory, graphics card and CPU heatsink are all black, and the cables and case fans are dark too. The metal inside the Corsair Carbide 400C is black, and all the hardware is highlighted by a single white strip of LEDs at the front. The lighting, dark hardware and large window may be simple, but it looks really neat and classy.

/ SPECIFICATIONS

CPU 4GHz Intel Core i7-6700K overclocked to 4.7GHz

Motherboard Asus Z170 Pro Gaming

Memory 16GB Corsair Vengeance LPX 3000MHz DDR4

Graphics EVGA GeForce GTX 980 Ti 6GB

Storage 500GB Samsung 850 Evo SSD, 2TB hard disk

Case Corsair Carbide 400C

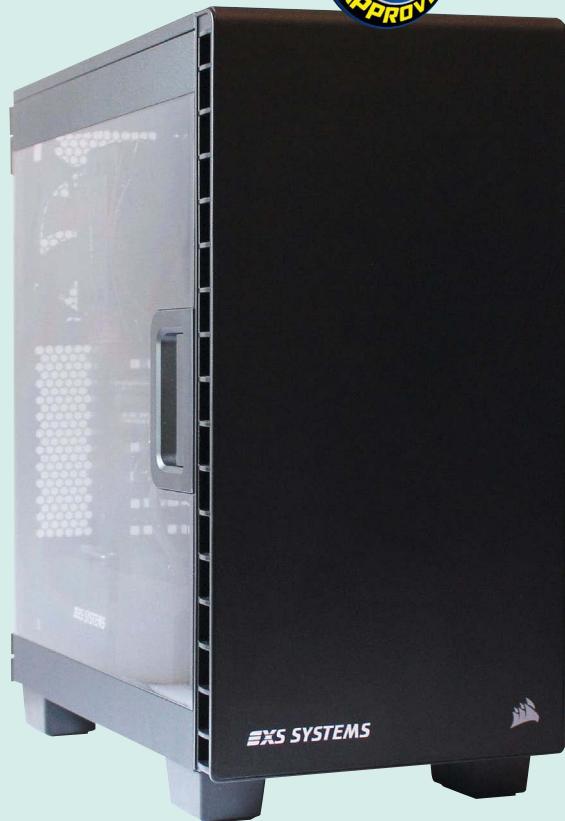
Cooling CPU: Be Quiet! Dark Rock 3 with 135mm fan; GPU: 2x 100mm fans; front: 1x 140mm; rear: 1x 120mm exhaust

PSU Corsair CSM550

Ports Front: 2x USB 3, 2x audio; rear: 4x USB 3, 2x USB 2, 1x PS/2, 1x USB 3.1 Type-A, 1x USB 3.1 Type-C, 1x Gigabit Ethernet, 1x optical S/PDIF, 5x audio

Operating system Microsoft Windows 10 Home 64-bit

Warranty Three years parts and labour, with one year on site and two years return to base



There's a lot to like on a practical level too. Typically for a Scan system, this PC is extremely tidy, and the PSU shroud handily holds a USB stick full of diagnostic tools. The dust filters are also magnetic, the windowed side panel opens with a handle and can be easily lifted free, and there's room around the back for more SSDs and hard disks in dedicated bays. The Carbide isn't large or loud, but it's quietly good.

Scan's usual three-year warranty is good as well, covering both parts and labour, with a year of on-site coverage followed by two years of return to base protection.

Performance

There's no doubt that this machine is geared up for VR. We ran Valve's SteamVR benchmark, which rated the Scan's performance Very High, never dropping below 90fps. The Scan has ample grunt for more conventional gaming too, achieving playable frame rates in all of our test games, even at 4K. The Crysis 3 and Fallout 4 minimums at 4K are only borderline playable, though, so it will be worth dropping a few settings here and there for a smoother experience.

The Scan is very quick in RealBench 2015, with an overall result of 152,855 showing that this PC can happily handle most workloads, and it's quicker than the Overclockers Titan Finesse Phoenix in these tests too. However, while its SSD read and write results of 488MB/sec and 477MB/sec are certainly quicker than a hard drive, they're a long way behind the results from the latest 3x PCI-E NVMe drives.

The thermal performance wasn't flawless either. The Scan's CPU delta T of 70°C is a tad high and we saw the CPU throttling back to 4GHz under heavy loads too, which is no

- 1** The Be Quiet! Dark Rock 3 has a hefty 135mm cooling fan
- 2** The EVGA GTX 980 Ti card ups the GPU clock to 1102MHz
- 3** Typically for a Scan system, this PC is extremely tidy



surprise, given that front air intake is only facilitated by one fan that pulls air through a couple of tiny vents. The GPU delta E of 56°C is better, but still not especially cool. Thankfully, the cooling system is quiet, being nearly silent when idle, and barely any louder during stress tests. The Be Quiet! Dark Rock 3 may be a good old-fashioned air cooler, but its use of a large 135mm fan with a fair-sized heatsink means it's quieter than most all-in-one liquid coolers, although the CPU gets hot.

Conclusion

Scan set out to build a VR-ready PC, and it's nailed the brief: this system has enough power for both VR and 4K gaming, plus it's well balanced, quiet, stylish and offers reasonable upgrade room, along with Scan's typically tidy building. Comparatively, Overclockers' slightly pricier Titan Finesse Phoenix is more extravagant-looking, and has NVMe storage (although only 128GB), and is a superior PC in

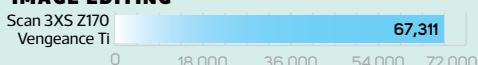


some respects, but the Scan is still a great system, with a simpler, classy appearance and a slightly cheaper price.

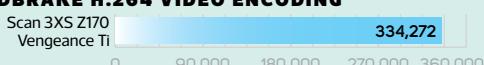
MIKE JENNINGS

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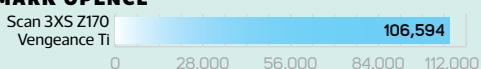
GIMP IMAGE EDITING



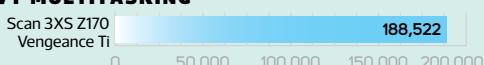
HANDBRAKE H.264 VIDEO ENCODING



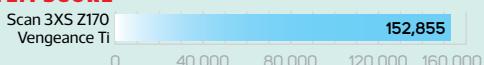
LUXMARK OPENCCL



HEAVY MULTITASKING



SYSTEM SCORE



INTEL REFERENCE: 133.55%

**SPEED
22/25**

**DESIGN
22/25**

**HARDWARE
22/25**

**VALUE
22/25**

**OVERALL SCORE
88 %**

BATTLEFIELD 4

2,560 x 1,440, Ultra Detail, TAA



3,840 x 2,160, Ultra Detail, TAA



THE WITCHER 3

2,560 x 1,440, High Detail, AA on, HairWorks off

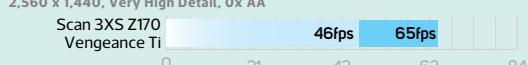


3,840 x 2,160, High Detail, AA on, HairWorks off



CRYYSIS 3

2,560 x 1,440, Very High Detail, Ox AA



3,840 x 2,160, Very High Detail, Ox AA



Minimum Average

VERDICT

Ample power for VR and 4K gaming in a fast, quiet, stylish and well-balanced machine.

GAMING PC

PC Specialist Vanquish Redline / £979 inc VAT

SUPPLIER www.pc specialist.co.uk

The Vanquish Redline isn't just notable for its temptingly low £979 price, but also for the orientation of the insides. Take a look through the Corsair Carbide 600C case's vast window and you'll see that the entire machine has been shifted across to the right, with the motherboard installed upside down.

The processor and memory sit at the bottom, with the graphics card above them, while the roof's covered area hides the PSU and storage bays. The Corsair Hydro H100i cooling unit sits towards the bottom, with its two tubes emerging to arc up to the waterblock. PC Specialist has also lined the base with red LEDs, illuminating the components from underneath.

The inverted layout is born of substance as well as style. Corsair says the low position of the components and absence of drive bays allows air to flow freely into the chassis, which can make a system cooler and quieter. The Carbide is also huge, measuring 260mm wide and 535mm tall, with plenty of room inside it. On the outside, it's dark and discreet, made from black metal and sporting small logos. It also has four USB ports and a fan controller on the top, magnetic dust filters on the bottom and a small door for the DVD writer. There are only single spare 3.5in and 5.25in bays free and two SSD bays empty, though, which is enough for most people's needs, but not that generous when you consider the machine's size.

Also, while the cables are routed out of the way, they're tied together in a big bundle at the top of the case, with no cables secured down anywhere, or purposely routed in straight lines, as you see in Scan's machines. The huge case is arguably overkill for this spec too. The potentially improved airflow from the layout might be handy in an LGA2011 machine with several GPUs, but this sub-£1,000 gaming PC's hardware is unlikely to benefit from that help.

The mid-sized graphics card inside the huge case is an XFX Radeon R9 380X. Its base clock of 970MHz has been boosted to 1030MHz, and the 4GB of GDDR5 memory has had its 5700MHz clock increased by 100MHz. There's also a Core i5-6600K Skylake CPU that's been overclocked to 4.6GHz.

Meanwhile, the Asus Z170-P covers the basics, enabling you to add another graphics card in CrossFire configuration, and it has plenty of SATA connections and on-board slots, as well as a free 4x PCI-E 3 NVMe M.2 port for adding a fast SSD later.

In some areas, though, the Z170-P is lacking. It doesn't have on-board buttons or a POST code error display, for example, although these features are admittedly of less importance in a pre-built machine than in a home build. Its



backplate is lacking too: it only has two standard USB 3 ports and two USB 2 ports, without much else of note, although at least there's a Type C USB 3.1 port.

Finally, PC Specialist's standard warranty is a three-year return to base deal with a month of collect and return coverage, although parts are only covered for the first year.

Performance

The Redline's R9 380X proved to be a successful 1080p performer. In Fallout 4 at Ultra settings, the Vanquish delivered a smooth minimum of 35fps, and it raised that frame rate to 45fps in The Witcher 3 with High detail. It handled Crysis 3 fine too, with a 36fps minimum. At 2,560 x 1,440, however, the Redline's 22fps minimums in Fallout 4 and Crysis 3 were below our playable threshold, although dropping the Fallout 4 detail to High will make it playable. On the plus side, the 33fps minimum in The Witcher 3 was a solid result.

This machine is a capable 1080p rig, but there's clear air between the Redline and GTX 970 machines at 2,560 x 1,440. PC Specialist's own Hailstorm GT (see Issue 146, p66) featured the same CPU and motherboard as the Redline, but also had a GTX 970 card, despite costing just £899, although the Redline admittedly has a better case and cooler. The Radeon R9 380X is fine for 1080p gaming at top settings, but don't expect it to go much higher.

The Redline's overclocked 6600K provided some reasonable pace in our RealBench 2015 suite too. It falls behind PCs based on the Core i7-6700K in our heavily multi-threaded video encoding test, but it has plenty of power for most people's needs. The SSD is surprisingly

SPECIFICATIONS

CPU 3.5GHz Intel Core i5-6600K overclocked to 4.6GHz

Motherboard Asus Z170-P

Memory 16GB Kingston HyperX Fury 2133MHz DDR4

Graphics XFX Radeon R9 380X 4GB

Storage 240GB Kingston HyperX Savage SSD; 1TB hard disk

Case Corsair Carbide 600C

Cooling CPU: Corsair Hydro H100i with 2x 120mm fans; GPU: 2x 90mm fans; rear: 1x 140mm fan; base: 2x 140mm fans

PSU Corsair CS650

Ports Front: 2x USB 3.2 x 1, USB 2, 2x audio; rear: 2x USB 3, 2x USB 2, 1x PS/2, 1x USB 3.1 Type-C, 1x Gigabit Ethernet, 6x audio

Operating system Microsoft Windows 10 Home 64-bit

Warranty One year parts and labour return to base, with first month collect and return, followed by two years labour only

1
The Corsair Carbide 600C chassis has an inverted layout

2
A Corsair H100i at the front keeps the CPU cool

3
The XFX Radeon R9 380 card is great for 1080p gaming

capable too. The SATA 6Gbps Kingston HyperX drive won't challenge the latest NVMe drives, but its respective sequential read and write speeds of 523MB/sec and 463MB/sec are fine.

Also, thanks to the modest components and huge, inverted case, this machine's thermal results were very cool. The CPU's delta T of 42°C at load is fine, thanks to the dual-fan Corsair H100i cooler, as is the GPU delta T of 46°C. Noise wasn't an issue either; the Redline is near silent when idle, and the fans don't make much noise during stress tests.

Conclusion

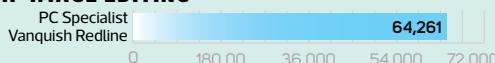
The Redline's Core i5 processor and R9 380X graphics make it a capable 1080p gaming system, and its solid benchmarks are backed up by plenty of RAM and a decent SSD. In other departments, though, the Redline isn't as accomplished. It's generally well built and good-looking, but it also takes up a lot of space for a comparatively modest system, and the H100i is overkill for a Core i5 6600K. A better balance at this budget could have been achieved with a GTX 970 card, 8GB of RAM and a less potent cooler. If you're looking for a well-built and quiet 1080p gaming system, the Redline is a good machine, but you'll need a better GPU to go beyond 1080p.

MIKE JENNINGS

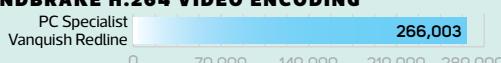


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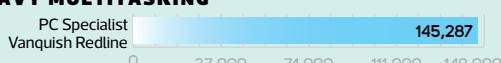
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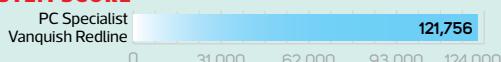
LUXMARK OPENCCL



HEAVY MULTITASKING



SYSTEM SCORE



INTEL REFERENCE: 106.38%

**SPEED
19/25**

**DESIGN
20/25**

**HARDWARE
20/25**

**VALUE
19/25**

**OVERALL SCORE
78%**

FALLOUT 4

1,920 x 1,080, Ultra Detail, TAA



2,560 x 1,440, Ultra Detail, TAA



THE WITCHER 3

1,920 x 1,080, High Detail, AA on, HairWorks off



2,560 x 1,440 High Detail, AA on



CRYYSIS 3

1,920 x 1,080, Very High Detail, Ov AA



2,560 x 1,440, Very High Detail, Ov AA



VERDICT

Quiet and fast in games at 1080p, but going beyond this resolution will require more GPU power.

Elite

Our choice of the best hardware available

Build a home theatre PC

The parts you'll need to build an affordable, home theatre PC that's ideal for putting in the lounge and playing back all manner of video formats. This machine will handle general computing and media tasks with no trouble, and its dual-core Skylake CPU can even handle 4K video playback. Meanwhile, its super-quiet Noctua CPU cooler prevents it from making a racket.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Lian Li PC-Q09FNB with 300W FSP SFX PSU	www.overclockers.co.uk	Issue 149, p92	£110
	Intel Core i3-6100T	www.overclockers.co.uk	Issue 149, p92	£96
	Asus H110i-Plus D3	www.scan.co.uk	Issue 149, p92	£62
	8GB Corsair 2133MHz Vengeance LP DDR3 (CML8GX3M2A2133C11B)	www.scan.co.uk	Issue 149, p92	£42
	Noctua L9i	www.scan.co.uk	Issue 149, p93	£32
	Samsung SN-208FB	www.scan.co.uk	Issue 149, p93	£13
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£54
	Samsung 850 Evo 250GB	www.scan.co.uk	Issue 141, p51	£67
	Logitech K400 Plus	www.dabs.com	Issue 149, p93	£31
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£87
TOTAL				£594

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Build a budget gaming PC

The parts you'll need to build a budget machine capable of playing the latest games at maximum settings on a 1080p monitor, and even some games at 2,560 x 1,440. The machine has a discrete graphics card, a Skylake dual-core CPU and DDR4 memory. The ASRock Extreme4 motherboard is also capable of base clock overclocking via a BIOS update.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	NZXT S340	www.overclockers.co.uk	Issue 137, p54	£60
	ASRock Z170 Extreme4	www.scan.co.uk	Issue 151, p84	£103
	Intel Core i3-6100	www.scan.co.uk	Issue 151, p18	£98
	8GB (2 x 4GB) Corsair Vengeance LPX 2400MHz (CMK8GX4M2A2400C16)	www.scan.co.uk	Issue 151, p83	£34
	Asus Radeon R9 380 Strix 2GB	www.ebuyer.com	Issue 150, p48	£167
	Samsung 850 Evo 250GB	www.scan.co.uk	Issue 141, p51	£67
	SilverStone Argon AR01	www.scan.co.uk	Issue 132, p57	£26
	EVGA SuperNova GS 550W	www.scan.co.uk	Issue 146, p50	£70
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£54
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£87
				TOTAL £766



ROG MAXIMUS VIII FORMULA Z170 GAMING MOTHERBOARD

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Build a mid-range PC

Work PC

The parts you'll need to build a solid quad-core PC with plenty of upgrade potential. This kit list gives you an all-in-one liquid cooler and a K-series Core i5 Skylake CPU, meaning you can overclock it and get some serious processing power. We've managed to get the Core i5-6600K Skylake CPU up to 4.6GHz, so it has some great performance potential. Also included is a solid EVGA PSU, a fast M.2 SSD and 8GB of high-speed DDR4 memory. The core configuration assumes you won't be doing any serious gaming, however, and it relies on Intel's integrated graphics.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	NZXT Phantom 530	www.overclockers.co.uk	Issue 127, p44	£98
	Asus Maximus VIII Ranger	www.scan.co.uk	Issue 147, p44	£154
	Intel Core i5-6600K	www.scan.co.uk	Issue 145, p17	£195
	8GB Corsair Vengeance LPX 2666MHz DDR4 (CMK8GX4M2A2666C16)	www.scan.co.uk	Issue 145, p24	£38
	NZXT Kraken X41	www.overclockers.co.uk	Issue 138, p57	£80
	EVGA SuperNova GS 550W	www.scan.co.uk	Issue 146, p50	£70
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£54
	Lite-On IHAS124-14	www.dabs.com	Issue 99, p108	£12
	Samsung SSD 950 Pro 256GB	www.ebuyer.com	Issue 149, p48	£138
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£87
TOTAL				£926

Gaming PC

The graphics card you'll need to play current games at their maximum settings at 1080p and 2,560 x 1,440.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	1,920 x 1,080 Asus Radeon R9 380 Strix 2GB	www.ebuyer.com	Issue 150, p48	£167
	2,560 x 1,440 Asus Strix GTX 970	www.scan.co.uk	Issue 150, p39	£282



Build a performance PC

Work PC

The parts you'll need to build a high-quality, fast PC that's ideal for multi-threaded workloads. This kit list features a high-quality, well-built case, a feature-rich motherboard and an Intel Skylake Core i7-6700K CPU. This processor's support for Hyper-Threading splits the resources of the CPU's four physical cores into a further four virtual cores, meaning it can effectively handle eight threads at once. There's also a solid Corsair 750W PSU, giving you plenty of headroom for overclocking and adding another GPU, 16GB of DDR4 memory, a high-speed M.2 SSD and an all-in-one liquid cooler.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Cooler Master Cosmos SE	www.cclonline.com	Issue 144, p41	£146
	Asus Maximus VIII Hero	www.overclockers.co.uk	Issue 146, p20	£177
	Intel Core i7-6700K	www.scan.co.uk	Issue 145, p17	£281
	16GB Corsair Vengeance LPX 2666MHz DDR4 (CMK16GX4M2A2666C16)	www.scan.co.uk	Issue 145, p24	£70
	NZXT Kraken X41	www.overclockers.co.uk	Issue 138, p57	£80
	Corsair RM750i	www.scan.co.uk	Issue 146, p55	£100
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£54
	Samsung SSD 950 Pro 512GB	www.ebuyer.com	Issue 149, p48	£246
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£87
TOTAL				£1,241

Gaming PC

The graphics card you'll need to play current games at their maximum settings at 2,560 x 1,440 and beyond.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	2,560 x 1,440 Asus Strix GTX 970	www.scan.co.uk	Issue 150, p39	£282
	4K 2 x Nvidia GeForce GTX 970 4GB	www.scan.co.uk	Issue 140, p50	£564

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and counting



Build a high-end 6-core PC

Multi-threaded PC

The parts you'll need to build a PC with serious power in multi-threaded software, such as 3D rendering apps, video editing programs and optimised distributed computing software. The kit list features a 6-core LGA2011-v3 CPU, which is overclockable using the motherboard and top-end cooler listed. Also supplied is 16GB of RAM, a super-fast M.2 SSD, 1TB of extra solid state storage and Asus' superb X99 Deluxe motherboard.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Phanteks Enthoo Luxe	www.eclipsecomputers.com	Issue 144, p53	£117
	Asus X99 Deluxe	www.overclockers.co.uk	Issue 136, p20	£335
	Intel Core i7-5820K	www.scan.co.uk	Issue 134, p43	£323
	Asus Radeon R9 380 Strix 2GB	www.ebuyer.com	Issue 150, p48	£167
	16GB Corsair Vengeance LPX 2666MHz DDR4 (CMK16GX4M4A2666C16)	www.scan.co.uk	Issue 136, p14	£80
	EKWB EK-Predator 240 Rev 1.1	www.scan.co.uk	Issue 148, p30	£168
	Corsair RM750i	www.scan.co.uk	Issue 146, p55	£100
	Samsung SSD 950 Pro 512GB	www.ebuyer.com	Issue 149, p48	£246
	Samsung 850 Evo 1TB	www.cclonline.com	Issue 141, p51	£250
	Lite-On IHAS124-14	www.dabs.com	Issue 99, p108	£12
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£87
TOTAL				£1,885

4K gaming PC

This LGA2011-v3 system can support multiple graphics cards over 28 PCI-E 3 lanes, making it an ideal foundation for high-resolution PC gaming, replacing the graphics card listed above with two high-spec cards.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	4K 2 x Nvidia GeForce GTX 970 4GB	www.scan.co.uk	Issue 140, p50	£564
TOTAL				£2,282



Build a mini PC

Core components

The parts you'll need to build either PC. This kit list gives you a solid PSU, 16GB of RAM, an overclockable Skylake CPU, an all-in-one liquid cooler and Windows 10 Home 64-bit. Also included is a short-PCB graphics card that can play current games at their maximum settings at 2,560 x 1,440, and a high-speed M.2 SSD.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Intel Core i7-6700K	www.scan.co.uk	Issue 147, p84	£281
	16GB (2 x 8GB) Corsair Vengeance LPX 2666MHz	www.scan.co.uk	Issue 147, p84	£70
	Corsair H80i GT	www.awd-it.co.uk	Issue 147, p84	£85
	Asus Strix GTX 970	www.scan.co.uk	Issue 150, p39	£282
	Samsung SSD 950 Pro 512GB	www.ebuyer.com	Issue 149, p48	£246
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£54
	EVGA SuperNova GS 550W	www.scan.co.uk	Issue 146, p50	£70
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£87

Mini-ITX PC

The parts you'll need to build a pint-sized powerhouse.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Fractal Design Define Nano S UPDATED	www.scan.co.uk	Issue 153, p22	£60
	Asus Z170i Pro Gaming	www.eclipsecomputers.com	Issue 147, p26	£124
TOTAL				£1,359

Micro-ATX PC

The parts you'll need to build a mini PC that doesn't take up as much room as a full-sized desktop.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Fractal Design Arc Mini R2	www.scan.co.uk	Issue 127, p46	£70
	Asus Maximus VIII Gene	www.overclockers.co.uk	Issue 147, p42	£174
TOTAL				£1,419



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Cases

	Type	Name	Supplier	Featured	Price (inc VAT)
	Budget ATX	NZXT S340	www.overclockers.co.uk	Issue 137, p54	£60
	Sub-£100 ATX quiet	Fractal Design Define R5	www.scan.co.uk	Issue 137, p20	£80
	Sub-£100 ATX performance	NZXT Phantom 530	www.overclockers.co.uk	Issue 127, p44	£98
	Sub-£150 full-sized ATX quiet	Nanoxia Deep Silence 5	www.quietpc.com	Issue 144, p50	£115
	Sub-£150 full-sized ATX	Phanteks Enthoo Luxe	www.eclipsecomputers.com	Issue 144, p53	£117
	Sub-£150 mid-size ATX	Cooler Master Cosmos SE	www.cclonline.com	Issue 144, p41	£146
	Mini-ITX tower	Fractal Design Define Nano S UPDATED	www.scan.co.uk	Issue 153, p22	£60
	Mini-ITX cube	Fractal Core 500	www.scan.co.uk	Issue 150, p20	£50
	Micro-ATX	Fractal Design Arc Mini R2	www.scan.co.uk	Issue 127, p46	£70

Graphics cards

	Type	Name	Supplier	Featured	Price (inc VAT)
	1,920 x 1,080 gaming	Asus Radeon R9 380 Strix 2GB	www.ebuyer.com	Issue 150, p48	£167
	2,560 x 1,440 gaming	Asus Strix GTX 970	www.scan.co.uk	Issue 150, p39	£282
	High-end single-GPU gaming	EVGA GeForce GTX 980 Ti Classified ACX 2.0+	www.scan.co.uk	Issue 147, p24	£589
	4K gaming	2 x Nvidia GeForce GTX 970 4GB	www.scan.co.uk	Issue 140, p49	£564
	Mini-ITX	Asus GeForce GTX 970 DirectCU Mini	www.cclonline.com	Issue 150, p38	£265

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Power supplies

	Type	Name	Supplier	Featured	Price (inc VAT)
	Mid-range 550W	EVGA SuperNova GS 550W	www.scan.co.uk	Issue 146, p50	£70
	High-end 550W	Super Flower Leadex Platinum 550W	www.oclockers.co.uk	Issue 146, p52	£88
	Mid-range 750W	Corsair RM750i	www.scan.co.uk	Issue 146, p55	£100
	High-end 1.2kW	Corsair Professional Series AX1200i	www.scan.co.uk	Issue 111, p40	£275

Networking

	Type	Name	Supplier	Featured	Price (inc VAT)
	Router	Asus RT-AC68U	www.cclonline.com	Issue 128, p88	£49
	Wi-Fi adaptor	Asus PCE-AC68	www.dabs.com	Issue 128, p88	£70

Storage

	Type	Name	Supplier	Featured	Price (inc VAT)
	Hard disk	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£54
	250GB SATA SSD	Samsung 850 Evo 250GB	www.scan.co.uk	Issue 141, p51	£67
	1TB SATA SSD	Samsung 850 Evo 1TB	www.cclonline.com	Issue 141, p51	£250
	High-performance M.2 SSD	Samsung SSD 950 Pro 512GB	www.ebuyer.com	Issue 149, p48	£246
	NAS box	Synology DS215j	www.cclonline.com	Issue 138, p17	£130

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Monitors

	Type	Name	Supplier	Featured	Price (inc VAT)
	24in monitor	Dell U2414H	www.overclockers.co.uk	Issue 129, p43	£189
	27in 4K monitor	Asus PB279Q	www.overclockers.co.uk	Issue 151, p40	£560
	27in FreeSync monitor	BenQ XL2730Z	www.overclockers.co.uk	Issue 143, p46	£456
	27in 4K G-Sync monitor	Asus ROG Swift PG27AQ	www.scan.co.uk	Issue 151, p42	£650
	27in 5K monitor	Dell UltraSharp UP2715K	www.scan.co.uk	Issue 151, p44	£938
	34in ultra-wide curved G-Sync monitor	Asus Republic of Gamers Swift PG348Q UPDATED	www.overclockers.co.uk	Issue 153, p28	£999

Peripherals

	Type	Name	Supplier	Featured	Price (inc VAT)
	Mechanical gaming keyboard	Cooler Master MasterKeys Pro S (Pro L version recommended if you need a numeric keypad)	www.box.co.uk	Issue 152, p44	£110
	Premium mechanical gaming keyboard	Corsair K70 RGB	www.amazon.co.uk	Issue 152, p41	£155
	Budget gaming mouse	Cooler Master Xornet II	www.cclonline.com	Issue 149, p28	£21
	Gaming mouse	Logitech G402 Hyperion Fury	www.scan.co.uk	Issue 139, p53	£39
	Ambidextrous gaming mouse	Roccat Kova	www.cclonline.com	Issue 150, p28	£50
	MMO gaming mouse	Corsair Scimitar RGB	www.cclonline.com	Issue 150, p17	£72
	Wireless gaming mouse	SteelSeries Sensei Wireless	www.overclockers.co.uk	Issue 139, p61	£110
	Flight stick	Saitek X-55 Rhino H.O.T.A.S.	www.overclockers.co.uk	Issue 131, p29	£170

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Audio

	Type	Name	Supplier	Featured	Price (inc VAT)
	PCI-E sound card	Asus Strix Raid DLX	www.scan.co.uk	Issue 148, p28	£150
	2.1 speakers	Acoustic Energy Aego M	www.amazon.co.uk	Issue 142, p52	£140
	Soundbar	Razer Leviathan	www.overclockers.co.uk	Issue 142, p57	£160
	Headset	HyperX Cloud II	www.argos.co.uk	Issue 142, p46	£70
	Surround-sound headset	Asus Strix 7.1	www.dabs.com	Issue 142, p43	£122

Systems

	Type	Name	Supplier	Featured	Price (inc VAT)
	Quiet gaming PC	Scan3XS Z170 Vengeance	www.scan.co.uk	Issue 151, p60	c.£1,500
	Dream PC	Scan3XS Barracuda	www.scan.co.uk	Issue 145, p58	c.£9,499
	Sub-£2,000 gaming PC	CyberPower Infinity X77 Deluxe	www.cyberpowersystem.co.uk	Issue 150, p56	£1,999
	Mini-ITX gaming PC	Chillblast Fusion Fury Nano	www.chillblast.co.uk	Issue 147, p56	c.£1,619
	Premium PC	Scan3XS X99 Carbon Extreme SLI	www.scan.co.uk	Issue 148, p62	c.£4,799
	Water-cooled PC	Overclockers Infin8 Toxicity	www.overclockers.co.uk	Issue 150, p58	c.£3,414
	Gaming laptop	CyberPower Fangbook 4 SK-X17	www.cyberpowersystem.co.uk	Issue 152, p30	c.£1,909
	Thin and light gaming laptop	Scan3XS LG15 Vengeance G-Sync	www.scan.co.uk	Issue 153, p51	£1,480

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Games



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RICK LANE / INVERSE LOOK

SCARY MONSTERS

Horror games have descended into a sequence of virtual fairground rides, argues Rick Lane

Horror games are stuck in a rut. Ever since 2010's *Amnesia: The Dark Descent* wowed critics and players with its terrifying twist on the traditional haunted castle, developers across the globe have been chasing the same pot of severed heads at the end of the same black rainbow. A pioneering concept six years ago has become an increasingly worn template, followed slavishly by an entire sub-genre of games, and it's time the mould was broken and forged anew.

Amnesia, if you haven't played it, was developed by the Swedish team Frictional Games, and was a culmination of work Frictional had begun several years previously in its *Penumbra* series. *Amnesia* was revolutionary in several ways. First and foremost, it removed any ability for the player to defend themselves; the only options were to run or hide from the monsters that lurked in Castle Brennenberg. In addition, the first-person perspective placed you directly inside the game's terrible environments, while its Insanity mechanic meant even a simple act, such as hiding in a darkened room, could prove dangerous, as the inability to see your surroundings slowly eroded your mental state.

Amnesia decoupled horror from its earlier role as parts of other games, be it 'survival horror' as seen in *Resident Evil* and *Silent Hill*, or spooky games from other genres, such as *Thief* or *System Shock*. A legion of games followed on in its wake, creating a whole new genre. Some of them are genuinely excellent, such as Red Barrels' terrifying *Outlast*, or *Gone Home*, which cleverly subverts many of the conventions established by *Amnesia*, using horror tropes to create a game about family and relationships. Yet many more of these games are middling to poor, and the quality has gradually declined over time.

The best horror makes us question how we act and behave

The problem with these games, which include *Kholat*, *Daylight*, *Among the Sleep* and most recently, *Layers of Fear*, is that, although they follow the structure of *Amnesia*, they fail to comprehend what made that game truly terrifying. It wasn't the monsters, or the fact that your virtual sanity was slowly unravelling; it was, without wanting to give too much away, realising the truth about your character.

Whether it's in books, films or games, the very best horror goes beyond corporeal mutilation or psychological manipulation, and makes us question how we act and behave daily as human beings. The reason *The Shining* is so often considered the best horror film in existence isn't because of what resides in room

237, but because of the corruption of Jack Torrance and the inevitable erosion of family ties – it's a horror story that occurs every day in real life. There's a fantastic scene early in the film in which Jack chastises his wife Wendy for interrupting his writing. It's a scene that's played out with worrying similarity in my own life, and seeing it reflected back at me is genuinely terrifying.

When a work of horror makes us sympathise with the monster, be it *The Shining*, *Frankenstein* or *Let the Right One In*, where we can rationally understand the trajectory to which an individual reached that point of degeneration, that's where true terror lies.

Gaming has incredible potential to explore this part of horror further, as it can place us in the shoes of those terrible individuals with whom we empathise. Unfortunately, with the advent of VR enabling us to experience the same cheap ghost trains in stereoscopic 3D, we're unlikely to see this more nuanced approach to horror anytime soon. **CPC**

Rick Lane is Custom PC's games editor. @Rick_Lane

The Division / £39.99 incVAT

DEVELOPER Massive Entertainment / PUBLISHER Ubisoft / WEBSITE www.ubisoft.com



Rainbow Six: Siege showed a side to Ubisoft that hasn't been seen for a long time – a willingness to take risks. Siege's slow-burning, tactical multiplayer shooting made it Ubisoft's most original title in years, giving an aging gaming genre a slick, modern spin that resulted in arguably its best game since Far Cry 3. The Division initially looked similarly fascinating, being a big-budget take on the brutal survival systems and fragile alliances seen in Bohemia Interactive's surprise hit DayZ.

However, the final game is a very different and far less adventurous beast. Its blend of third-person cover shooting and MMO-style progression isn't entirely without its merits, but it fails to either innovate or excel in any notable fashion.

The Division takes place in New York after a distinctly unnatural disaster. Terrorists unleash a deadly virus into the city, and the US government responds by cordoning off Manhattan. This action prevents the outbreak from spreading, but the civilians trapped in the Big Apple's rotting core feel abandoned by the state and resort to rioting, looting and factional infighting. Accordingly, the government responds again, this time by sending squads of specially trained operatives known as The Division to sort out the situation with bullets.

So commences another gigantic, open-world complete 'em up, which includes around 25 hand-crafted missions, and hundreds of cut-and-paste activities that coat your game map like sprinkles on a cake. Unlike most of Ubisoft's games, however, The Division is designed entirely with cooperative play in mind. You team up with other agents, complete missions, earn experience points, gradually unlock new skills and acquire new weapons.

Structurally, the result resembles a Mass Effect MMO, only with a far less interesting story and setting. Ubisoft's rendition of a snowbound New York is astonishingly pretty, with incredible attention to detail, razor-sharp textures, and a lighting engine that rivals Crystal Dynamics' sterling work in Rise of the Tomb Raider. Unfortunately, around 90 per cent of these amazing assets amount to little more than window dressing. Unless you're actively on-mission, there's little life to the city. Other players who aren't in your group don't appear on the streets, and all of the game's interactive elements simply sit and wait for you to come along, giving the environments an eerie, theme park-like feel.

The Division only truly kicks into gear when you enter into one of the main 'story' missions. Here, the meat of the game reveals itself; a challenging series of cover-shooter gauntlets where tactical use of cover and skills are key to success. Enemies are tough and aggressive; stepping out of cover will quickly see you filled with more holes than a designer jeans shop. To avoid this situation, your team must work together to suppress the enemy and move down the flanks to get clear shots.

The Division's combat system is undoubtedly its strongest asset, yet while it's tactically engaging, it lacks flair or much of a sense of impact. The game's approach to creating a challenging situation is simply to spawn

multiple enemies with large health bars. It works, but it doesn't make for a particularly interesting or tense situation.

Worse, once the novelty of the city and the joy of playing with friends wears off, you're essentially left to grind through very similarly structured levels for a slightly better gun. Completing missions and side objectives rewards you with an array of different points that can be spent at your Base of Operations, where you can upgrade your agent's skills and stats – it's essentially a menu you can walk around. Regrettably, though, only a handful of the available skills are useful, which means you're largely stuck with improving your base stats and equipment – hardly thrilling interaction. The game tries to inject some personality with cut-scene laden mission briefings and a range of quirky NPCs, but most of them are irritating rather than fun.

The Division is rescued from disaster, however, by its player vs player (PvP) component. The Dark Zone is a walled-off section of Manhattan, and the epicentre of the virus' spread. Here lurk the toughest enemies in the game, but also the best loot. Any upgrades collected in the Dark Zone can't be used immediately, as they have to be extracted by helicopter for decontamination. However, calling in a helicopter attracts AI enemies and other players to your location. Unlike in other areas, these players aren't beholden by the game's rules to help you, and may even try to kill you and steal your hard-earned equipment.

What results is the exact kind of tense, emergent play the rest of the game lacks. Your mind becomes much more focused on the incredible surroundings as you watch for other players' movements, and each encounter with Division agents leaves both parties wondering whether the other player will shoot first. Anyone who kills a fellow agent is labelled 'Rogue', giving everyone else in the Dark Zone a temporary licence to kill. Doing so earns that particular agent a hefty credits bonus. If the Rogue player survives until the bounty runs out, they reap the rewards.

The Dark Zone has its problems, though. Players have a tendency to exploit the Rogue system by running into other players' lines of fire, giving them a free pass to murder the unsuspecting agent. It also lacks the scope and variety of its obvious inspiration, DayZ. However, the Dark Zone represents The Division at its best, a roiling crucible of endlessly forged and broken alliances that's thrilling when played with friends and terrifying when played solo.

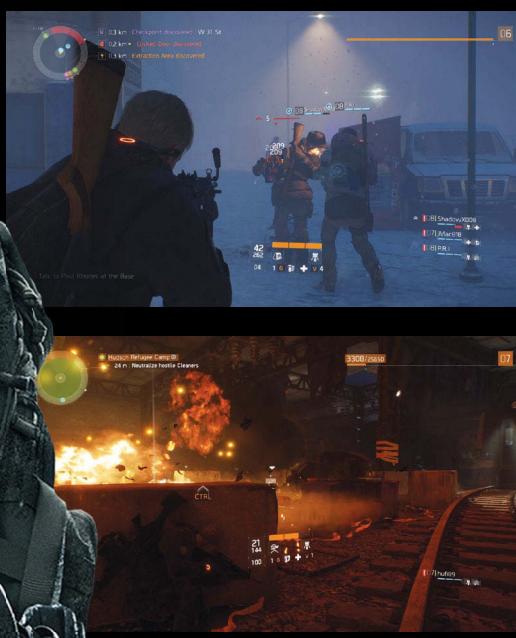
Sadly, the Dark Zone only amounts to around a quarter of the overall game, when it should be the basis for the whole. The cooperative side is entertaining in patches, but there are also long stretches of tedium. It's a mishmash of hackneyed systems that only grudgingly work together, like Dark Zone agents gunning for each other's loot. What could have been the most daring mainstream game in years is instead a forgettable chase for trinkets. It's worth a look if you have plenty of gaming friends and you've exhausted other cooperative options, but otherwise, this particular viral strain is best left in isolation.

RICK LANE

OVERALL SCORE
60%

/ VERDICT

Aside from its splendid Dark Zone component, The Division plays it too safe for its own good.



The Witness / £30 incVAT

DEVELOPER Thekla, Inc / **PUBLISHER** Thekla, Inc / **WEBSITE** www.the-witness.net

Eight years since the highly praised platformer Braid, Jonathan Blow has finally released his second game, *The Witness*. It's an open-world puzzler set on a gloriously colourful abandoned island. The premise is simply that you wake up on this island and begin solving mazes.

These mazes are displayed on flat grey screens that stand in stark contrast to the picturesque landscape, and they're completed simply by tracing a line from a circular starting node to a pulsing end point. There are so many mazes that, by the time you've finished *The Witness*, you'll be qualified to join Leonardo DiCaprio on a mission to plant ideas in somebody's brain.

It's a bold idea to frame an entire game around one type of puzzle, but it soon becomes clear that these simple puzzles are only part of a much larger conundrum – the island itself. It isn't long before the mazes increase in complexity, with the game hinting at oblique solutions with abstract icons, such as black and white dots or Tetris-style shapes. *The Witness* never explicitly tells you what these symbols mean, but there are sequences of puzzles that introduce you to different concepts.

OVERALL SCORE
85%

/ VERDICT
A sumptuous and rewarding puzzle game, *The Witness* falls just short of brilliance because of its aloof approach to narrative.



After a while, *The Witness* begins inverting and combining these symbols to create extremely challenging puzzles, which you'll only be able to solve if you understand what those symbols represent. In effect, the game is subtly teaching you a new alphabet in order to understand its enigmatic language, and with each new letter you learn, the more the island opens up to you.

It's an extraordinarily rewarding experience, aided by the elegance with which all the game's components are connected – both directly and indirectly. Many puzzles are strung together with wires that lead through specific

Layers of Fear / £14.99 incVAT

DEVELOPER Bloober Team SA / **PUBLISHER** Aspyr / **WEBSITE** www.layersoffear.com



Layers of Fear's developers are quick to reference their artistic inspirations from the gothic artworks of Francisco Goya and Henry Fuseli but, in terms of execution, Bloober Team's debut is less a horror masterwork and more a funfair ghost train. It's a decent ghost train, however, being moody, unpredictable and offering up genuinely effective scares.

It casts you as an artist whose creative aspirations are restricted by his lack of success and the need to support his family. The resulting stress eats away at his sanity, and we're introduced to him as he returns home to

OVERALL SCORE
60%

/ VERDICT
Layers of Fear's environmental trickery impresses at first, but the game needs a more substantial undercoat in order to shine.



finish his latest and greatest work, at which point his mind begins to unravel faster than a Damon Lindelof plot.

Layers of Fear's key gimmick is how it manipulates the environment and plays with your perspective. The house's layout is constantly shuffled around you – returning through a door through which you've just walked will often lead to an entirely different room.

The game can even change a room's contents while you're standing in it without you noticing. It's clever stuff – pictures are rearranged, corridors added and furniture thrown around. *Layers of Fear* uses this system to depict





sequences, while sometimes you stumble across a maze providing a solution to a puzzle you met hours beforehand.

The Witness' narrative is equally arcane. The island is littered with mysterious stone statues posed in suggestive ways, while audio logs are hidden in secret locations and quote from great works of literature. There's even an underground cinema that plays excerpts from old documentaries and other filmic curiosities. All of it hints at a grander meaning or message but, unlike the majestically interconnected puzzles, the solution never becomes completely clear.

Such ambiguity isn't necessarily a problem, but *The Witness* does feel quite cold. The environment art may be highly photogenic, but during play, the scenery is eerily still. It gives the sense of wandering through a museum – always interesting but rarely arresting. This feeling extends to the storytelling. The disinterest in providing any coherence to the narrative fragments leaves you feeling oddly distanced from the world. The narrative doesn't make *The Witness'* puzzle design any less ingenious, but it does prevent it from being a masterpiece.

RICK LANE

the artist's downward spiral and set up jump-scares. It's most effective at the latter, drawing your attention to an area with a blinking light or a creaking door, then shuffling the scenery while you aren't looking. With a compelling story, it could be an excellent horror game, but the story is where it falls down.

The plot allegedly explores the fractious relationship between the artist, his wife and his daughter, but we're given little more than a glimpse of the latter two characters, making it difficult to care about them. The game's exploration of insanity is also shallow, boiling down to 'crazy people see weird stuff and do bad things!' while the voice acting would seem overdone in a local village pantomime. What's more, because *Layers of Fear* assaults you



incessantly with jump-scares, you become immune to them after an hour or so, revealing the game's underlying hollowness.

Aside from being able to open doors, flick light switches and pull levers, there's little interaction. There's a handful of puzzles, but they're very simple and achieve little more than adding 30 seconds of run time.

Towards the end, the protagonist has a brief spell of clarity. We catch a glimpse of his true feelings, and the game almost gets to grips with the tragedy of madness, before slipping back into cheap cliché and spoiling what could have been a great ending. In short, *Layers of Fear* offers a flicker of genius in an otherwise well-produced but derivative experience.

RICK LANE



SUPERHOT / £18 incVAT

DEVELOPER SUPERHOT Team / **PUBLISHER** SUPERHOT Team /
WEBSITE <http://superhotgame.com>



Few games arrive with such a singularly powerful idea as SUPERHOT. In this icy-cool FPS, the notion of 'bullet-time', where time slows down when the player presses a button, is flipped on its head, resulting in a world where time only moves when the player moves. In actuality, time still flows onwards in SUPERHOT, even when you're standing still. It just moves very slowly. Bullets crawl through the air like snails in space, while the glittering Red Guys – the only enemy type – float glacially towards you like bright orange icebergs. The moment you take a step, however, time accelerates, and the longer you move, the closer time approaches normal speed.

This mechanic creates a unique puzzle game. Structurally, it's broken up into individual combat scenarios, ranging from a bar brawl to a shootout in an elevator. Although time is on your side, the enemy has numbers in its favour. Consequently, the air is often filled with a deadly rain of projectiles. Rather than reacting on instinct, you're making deliberate, sweeping motions to avoid bullets and attempting to figure out the most efficient way of dispatching your opponents.

Giving you control over time also creates a delightful action sandbox, and you can not only choose the most effective way of dealing with enemies, but also the most stylish. For example, weapons only have a few shots each and can't be reloaded, but you can throw an empty gun to stun an enemy. Doing so will also cause them to drop whatever weapon they're carrying, which can then be plucked out of the air and used to finish them off. At the end of a stage, the action is replayed in real time, and those replays can be recorded, edited and uploaded to the 'Killstagram' website.

SUPERHOT is wickedly cool, although the developers clearly know this fact and play up to it, which works both for and against the game. The aesthetics, for example, are great. Environments are rendered in crisp shades of white, while the Red Guys shatter into thousands of



triangular shards when shot, lending the violence a clean, artistic elegance without reducing its impact.

Less impressive is the story – a highly self-referential piece of fiction about the player's experience of playing SUPERHOT, starting as a discovery of this underground, half-finished indie game, before becoming more sinister. It's reminiscent of Davey Wreden's *The Beginner's Guide*, but lacks the ambiguity and subtlety of narrative to make the effect convincing. It comes across as smug, and the frequent narrative interruptions upset the fantastic flow of those wonderfully constructed action-sandboxes.

Nevertheless, the allure of SUPERHOT's central conceit is compelling, and the style with which it's executed easily outweighs the clumsy approach to storytelling. It's the most mechanically interesting shooter in years, and an absorbing experience from start to finish.

RICK LANE

OVERALL SCORE
82%

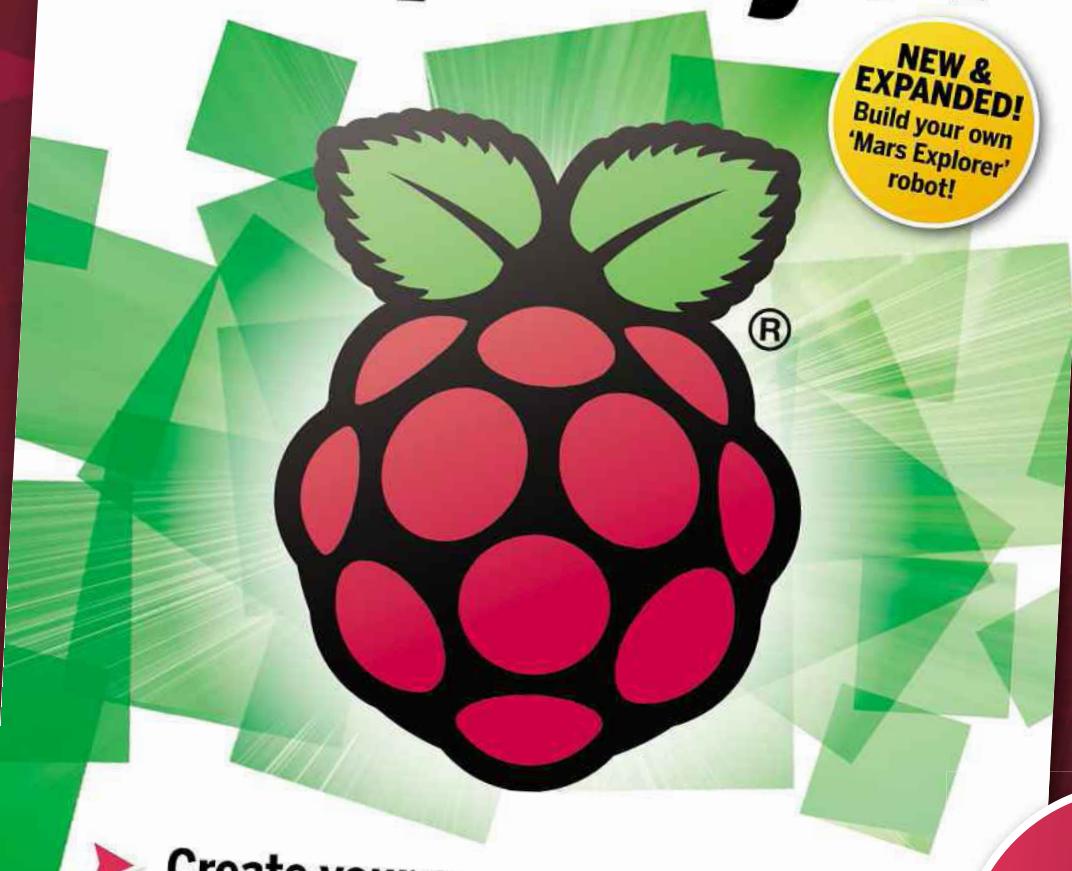
/ VERDICT
A wickedly stylish and effortlessly cool shooter, although it isn't quite as intelligent as it thinks it is.



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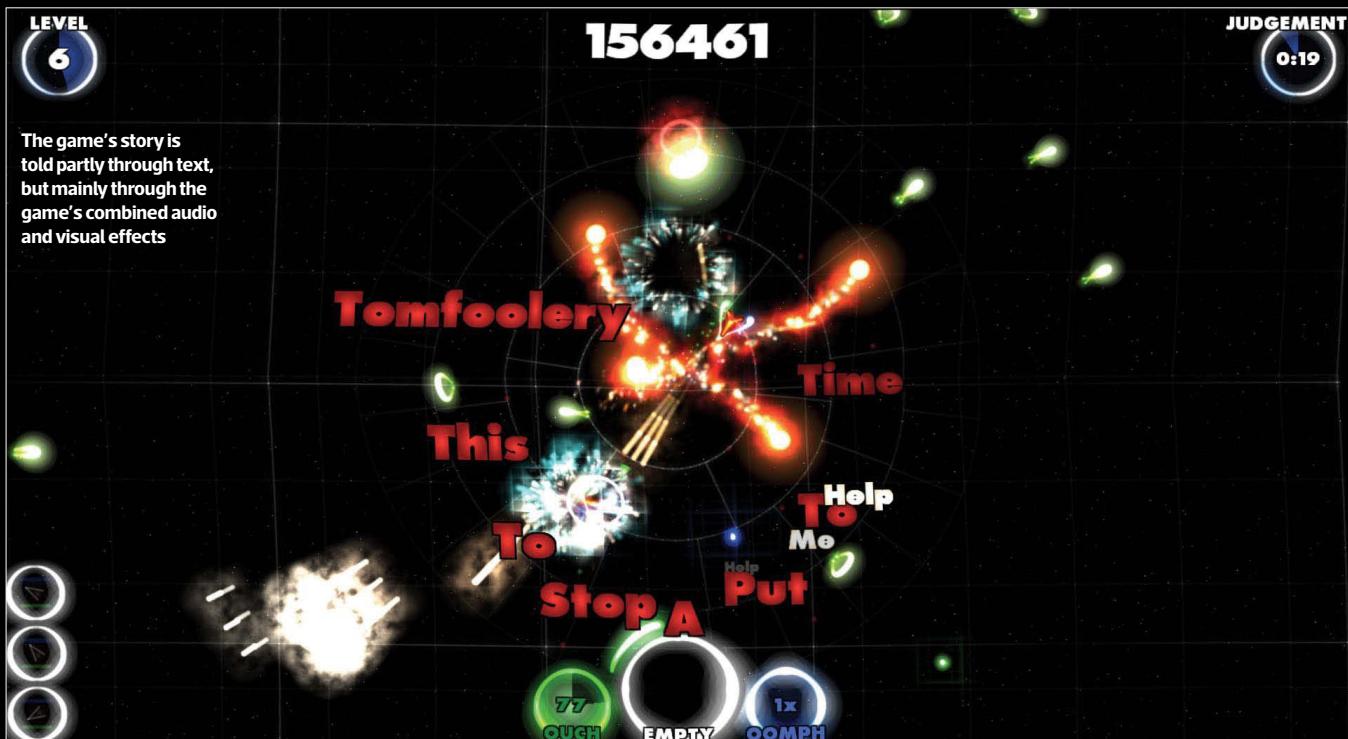
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RICK LANE / THE ENGINE ROOM

BezierSynth

Can particles form the basis of an entire game? Rick Lane talks to Phillip Bak about the tech behind twin-stick shooter Bezier

Particles are a key component of modern game engines. From motes of dust glinting in simulated sunlight, to sparks floating from fires and spraying from explosions, particles offer an easy way to add a large amount of detail to a scene. They can be used to create weather systems such as snow and rain; plus, when combined with animation and a little ingenuity, they can represent distant flocks of birds, or leaves being blown off trees to simulate wind.

But can particles form the basis of an entire game? This idea was the starting point for Bezier, a furious twin-stick shooter that combines spectacular visuals and action with an introspective story that explores religion and evolution. It also crams more particles into a

single scene than an explosion at a Smarties factory.

Bezier is the creation of Phillip Bak, an eight-year project that launched in February this year. A hobbyist programmer for over 20 years, Bak had tinkered with and then given up on game design three times – in 1992, 2001 and 2005 respectively. Three years later, he started tinkering again. ‘I’d tell my wife I was just messing around, and she’d laugh and say, “You’re making a game”,’ Bak says. ‘I think I finally admitted it to myself around Christmas 2008, about nine months in.’

At the outset, Bak’s requirements from the Bezier Engine were straightforward. ‘Draw particles and curves. Lots of them,’ he says. Being a programmer with a self-admitted lack of talent for visual art, Bak was

limited in terms of how he could represent objects on-screen. However, particles and particle effects enable any programmer to produce impressive visual effects without having to draw.

Indeed, Bak has been fascinated with particles since the late 1990s. ‘I wanted to make a whole game with particles, but unfortunately, CPUs just weren’t fast enough and they still weren’t fast enough in 2008 when I started Bezier. I did a demo on the CPU, which was fancy but slow. My friend who was working on rendering engines at EA took one look and said, “Get that on the GPU,” and that changed everything.’

Even though Bezier is built on DirectX 9 shaders, it averages between 50,000 and 200,000 particles per frame without



encountering any performance issues. Yet all those particles are useless if they aren't sculpted into a game. Interestingly, Bezier was coded almost entirely in Windows XP's Visual Studio, with little in the way of bespoke tools built for the game. 'I wrote an editor to audition/tweak the curves but everything is procedurally built up from scratch,' says Bak. 'At the last count, I think I had five or six different particle systems in the code.'

Much of that procedural development went into Bezier's range of enemies. There are well over 100 different adversaries in Bezier, all of which are visually represented by simple shapes and curves. Some enemies are essentially squares that subdivide, while others resemble strands of DNA, segmented centipedes and organic cells. However, Bak's approach to creating these enemies was far more involved than hand-drawing a few shapes. 'The story is set 400 years in the future, so I went back 400 years and stole the characters from a few popular connected stories. I don't want to ruin the discovery but I took whole chunks of text from these stories (by a certain English playwright) and ran it all through my shape generators. A lot of what came out was trash, but every so often, I'd see something coherent and strangely beautiful, and I'd then capture the seeds.'

To produce Bezier's broader aesthetic, these shapes are then overlaid with 'additive blended particles', which are controlled by a pixel shader Bak created himself. 'Around 99 per cent of everything on-screen is rendered with a simple blob texture using one shader,' he explains. 'It's very simple. I cracked the shader that does it after two bottles of wine one evening. I woke up and it was working – I didn't fully understand it and I still don't. It takes up all kinds of variables from the game and drags them down on to the GPU. I showed it to my rendering friend and he just asked, "What the hell is this?" I've not touched that shader since.'

Bezier's music is also a crucial component. Over two years Bak composed a 90-minute score that



communicated not just through on-screen text, but via the 'feel' of playing the game itself. 'As an industry, we seem to want to sweep the programmers aside and make it as easy as possible for writers and designers to guide the story,' says Bak.



'That rarely works well because a game is a painting and the programmers are holding the brush. We should find programmers who can tell a story and let them loose. Jon Blow, Tim Sweeney, John Carmack and Hidetaka Miyazaki are all programming storytellers.'

As part of this idea, verbal explication in Bezier is kept to a minimum. 'I wrote a whole short story and then worked it down to a handful of lines. The rest is still there, just being fed into procedural generators creating shapes and movements' says Bak. In other words, every object that appears on screen has a literary basis. The game isn't just telling a story – it's created by it.

Whether or not this aspect of Bezier is entirely successful is debatable. In particular, the intensity of Bezier's action means there isn't much time to think about anything other than avoiding obliteration. Nevertheless, it's a fascinating idea, and Bezier highlights the importance that individual technologies can play in a particular project – when employed with a careful eye, a simple particle generator can be transformed into art. **CPC**

blends live instruments with sample libraries and VST synths, the latter of which he coded by running Bezier's story variables through them. The music is closely connected with the on-screen action, intended to aurally represent what occurs on-screen at any time. Bak even had the score mixed and mastered at Pinewood Studios. 'That was a surreal moment,' he says, 'listening to my music playing at deafening volume through a setup that probably cost more than my house.'

The importance of Bezier's music to Bak indicates his overall design philosophy. Bezier is intended to be a holistic experience where nothing in the game stands apart. So the game's story, in which humanity is saved from extinction by transferring it into a digital archive, is

The game can produce between 50,000 and 200,000 particles per frame



How to BUILD A MICRO, WATER-COOLED, 8-CORE GAMING RIG

Super-fast water-cooled PCs don't have to be obelisks. Antony Leather shows you how to squeeze all the gear into a pint-sized chassis if you're prepared to get your hands dirty

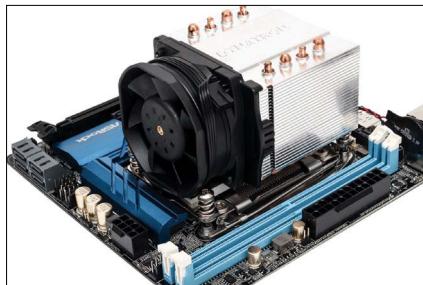
We usually stick to simple build guides in **Custom PC**, but this month we're going all out with a proper customised PC. We'll show you how to build one of the smallest, most powerful water-cooled systems on the planet. By making a few simple modifications to one of the smallest cases on the market – Raijintek's Metis, we've made room for a capable, custom water-cooling system to build a monstrous PC in a case the size of a shoebox.

We haven't settled for low-spec hardware here. If you're building the most powerful PC possible, you need to take advantage of Intel's X99 platform and we've managed to squeeze an X99 motherboard, along with a Core i7-5960X CPU, into a mini-ITX case. We've also selected a high-end graphics card – Nvidia's GTX 980 Ti – and carefully chosen some custom water-cooling components to keep all the hardware cool.

Over the next few pages you can see how we've done it and, if you're interested in having a go yourself, you can see the first steps you need to take in order to mod the Metis chassis in this month's How to guide on p102. However, we've also shown how to build a similarly potent system without modding the case or delving into custom water cooling.

Modding the case

We've discovered that Raijintek's Metis is a fantastic case for modding, and you can see how we've changed the internal layout using little more than a Dremel and some filler on p102. By moving the motherboard tray to the middle of the case, we've made room for a large 140mm radiator behind it, and by lopping off a little of the motherboard tray,



If you don't want to delve into the dark arts of water cooling, you can replace the motherboard's included air cooler with a Cooler Master Seidon 120

we've made way for a larger graphics card and pump.

However, there are several ways to go about building our system. Firstly, if you don't want to do any modding or delve into the dark arts of water cooling, you can use the motherboard's included air cooler or use an all-in-one liquid cooler with our chosen motherboard. The ASRock X99E-ITX/ac is our motherboard of choice, but it isn't compatible with many LGA2011 coolers, as it has a narrow CPU socket to save space on its



cramped PCB. However, Cooler Master's Seidon 120 series of coolers fits, and the single 120mm-fan model also squeezes into the Metis case. You'll need to leave your graphics card air-cooled though.

You could also consider using an external water-cooling system, which will only require you to drill a couple of small holes in the case, allowing you to water-cool both the graphics card and CPU. Luckily, we did just that in last month's modding guide and used the Metis as our test subject (see Issue 152, p102).

HARDWARE SHOPPING LIST

CASE

Raijintek Metis / £35 inc VAT
SUPPLIER www.occlockers.co.uk

The Metis is a fantastic case for modding and also features mostly aluminium construction, despite its sub-£40 price tag. It offers just enough space for a cooling system that can deal with our monster hardware.



CPU
Intel Core i7-5960X / £875 inc VAT
SUPPLIER www.scan.co.uk



As a mini-ITX system lacks the ability to tap into the extra PCI-E lanes for enhanced multi-GPU performance, you could consider opting for a Core i7-5820K. However, if you want the extra two cores to get the ultimate multithreaded performance, the Core i7-5960X is the only way to go.

MEMORY
32GB 3200MHz
Corsair Vengeance LPX
DDR4 / £176 inc VAT
SUPPLIER www.scan.co.uk

We're going all out with the rest of our hardware this

month, so we decided to raise the stakes with the memory too. We've opted for one of the fastest 32GB dual-channel kits around, and there's enough memory here for tough rendering tasks.

GRAPHICS CARD

Overclockers GTX 980 Ti Reference Design / £559 inc VAT
SUPPLIER www.occlockers.co.uk

There are a number of GTX 980 Ti PCB designs and sizes, but you'll need to use a reference model so that the PCB fits inside the case (some are too long), and to make sure the waterblock will fit. We chose Overclockers' own-branded reference model, so we can be sure it will accommodate our chosen waterblock and fit inside our tiny case.



MOTHERBOARD
ASRock X99E-ITX/AC / £230 inc VAT
SUPPLIER www.occlockers.co.uk



So far, ASRock is the only motherboard manufacturer to offer an X99 mini-ITX motherboard. The main feature this board is missing over its larger siblings is quad-channel memory support – it only has two slots, but

dual-channel bandwidth will be fine for most people. It also only has one PCI-E slot, but our system's GTX 980 Ti card will mean it's still fast in games.



PSU
Corsair SF600 / £100 inc VAT
SUPPLIER www.scan.co.uk

The key to making space in the Metis is using an SFX PSU, which will be much smaller than the ATX equivalent. Corsair's latest SFX models use large 92mm fans that can switch off at low loads for silent operation. We're using the 600W model, which is fully modular.



SSD
512GB Samsung 950 Pro / £240 inc VAT
SUPPLIER www.occlockers.co.uk



There's plenty of space for 2.5in SSDs in our system, but as the motherboard supports M.2 models, we've opted for the best of the bunch, which is currently Samsung's 512GB 950 Pro. It offers

extremely fast sequential read and write speeds, and its half-terabyte capacity means we don't have to worry about mounting drives elsewhere.

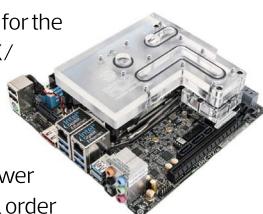
CPU WATERBLOCK

Bitspower ASRIX99
ASRock X99E-ITX/ac /

£117 incVAT

SUPPLIER www.bitspower.com.tw

As the waterblock for the ASRock X99E-ITX/ac is the only one of its kind, and the board itself is fairly niche, Bitspower offers a direct mail order service for this block. It's well worth jumping through this hoop to get it though – the waterblock looks fantastic and it's well-made, plus it cools the VRMs and chipset, both of which are known to get toasty on X99 motherboards.



GPU WATERBLOCK

EKWB EK-FC Titan X /

£77 incVAT

SUPPLIER www.watercoolinguk.co.uk

Reference models of the GTX 980 Ti use the same PCB as the Titan X, so you can use the already established full-cover waterblocks for the latter to cool your card. We went with the nickel version.



PUMP

XSPC Ion / **£49 incVAT**

SUPPLIER <http://shop.xspc.com>

XSPC's Ion has very compact dimensions and includes a relatively powerful pump and reservoir, all in the same package. The aluminium casing looks fantastic and you even get a view of your coolant through a bevelled-edge window.



RADIATOR

Black Ice SR2 Xtreme+
140 MP / **£52 incVAT**

SUPPLIER www.watercoolinguk.co.uk

There's limited space for a radiator in our case, and ideally, we'd like a larger radiator to cool our monster hardware with as little noise as possible. However, despite its comparatively small width, the Black Ice SR2 Xtreme+ 140 MP is a monster radiator, with more cooling capacity than any dual-fan, all-in-one liquid cooler. Backed up by our powerful pump and Noctua 140mm fan, it offers just enough cooling power to deal with our CPU and graphics card.



FITTINGS AND TUBING

13/10mm fittings
and tubing / **£30 incVAT**

SUPPLIER www.watercoolinguk.co.uk

Using rigid tubing in such a small build would be very difficult, especially when dismantling or draining the system. Therefore, we decided to go for 13/10mm flexible tubing and fittings. This size and flexibility is ideal for working in small spaces.



RADIATOR GRILLE

140mm fan filter
mesh frame /

£4 incVAT

SUPPLIER www.watercoolinguk.co.uk



COOLANT

Mayhems Pastel Red /

£11 incVAT

SUPPLIER www.watercoolinguk.co.uk

As there isn't much coolant on show in our system, we've opted for a standard colour in the form of Mayhems' Pastel Red. A more lavish coolant, such as Mayhems Aurora 2, would be wasted here.



BUILDING THE PC

01 MAKE PUMP MOUNT

Depending on the pump you use, you may want to raise it off the floor so it's visible or easier to access. We created a small mount using an off-cut piece of aluminium sheet that we used to modify the case in this month's modding guide. We topped this sheet with double-sided adhesive neoprene; along with the tubing, this will hold the pump in place. It's not a good idea to mount the pump straight to the case, as it can result in noise and vibration.

02 APPLY VELCRO PADS TO PSU

Normally, you can secure an SFX PSU to an ATX PSU mount using an included adaptor. However, to make way for our pump we need to shift the PSU to one side, which means securing it by other means. At the front of the case is a blank aluminium panel, which is where we'll mount our PSU using 3M Damage-free hanging adhesive pads.

03 SECURE PSU

The pads are essentially strong Velcro, which makes it easy to mount and remove the PSU. With both sides of the pads attached to the PSU, remove the protective stickers, then press the PSU firmly into place. When you remove it, the case side pads will stay in place, ready for you to remount it. To improve the aesthetics, we've also ditched the rear-mounted PSU extension port and simply connected a right-angled power lead to the PSU through the existing PSU vent.

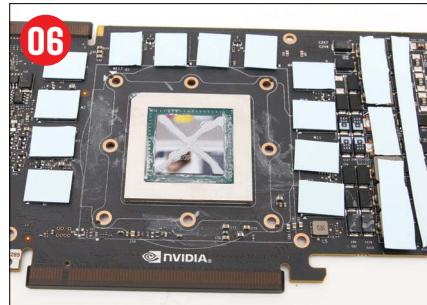
04 MAKE A DRAIN PORT

With any small system, a drain port can be useful for filling and draining the system. Our radiator sports several ports, and one handily points at the rear of the case. We used an Alphacool bulkhead pass-through fitting, along with a double nipple fitting and two G1/4in outer threads, to connect the pass-through fitting to the radiator. Line up the radiator with the fittings attached, and then mark up the position for your drill – you need a 20mm hole. You can then detach the pass-through fitting and pass it through the hole so you can fill or drain the system externally.

05 REMOVE GPU COOLER

The cooler on the GTX 980 Ti card is easy to remove, just needing a small crosshead screwdriver to deal with the screws on the PCB and rear bracket. With all the screws removed, detach the light and fan cables, and carefully remove the cooler.

TOTAL PRICE: £2,555 inc VAT



06 APPLY THERMAL PADS AND PASTE

Clean off any old thermal paste using TIM cleaner or isopropyl alcohol, then follow the waterblock's instructions to apply the included paste and thermal pads. The paste is applied to the GPU core, and the pads need to be cut up and stuck to the memory chips and VRMs.

07 FIT GPU WATERBLOCK

The port side of the GPU waterblock should reside on the same side as the GPU power connectors. Lay the block on a raised, flat surface, then align the PCB face down on top of it, lining up the four main holes around the GPU core and securing these screws first.

08 MARK UP SIDE PANEL

We've used a 140mm fan grille, so our radiator can exhaust air from the case. Dismantle the filter so that you can use the inner ring as a template for the fan exhaust.

09 CUT OUT FAN BLOWHOLE

You can use a holesaw for this job, but it's just as easy to use a Dremel by angling a cutting disc a little, so you can gradually work your way around in a curve. You'll then just need to file the edges.

10 FIT FAN GRILLE

Drill some holes to attach the fan grille. We've used standard fan-mounting screws with a 5mm thread diameter. Drill with a 4mm

or 4.5mm drill bit, then use a fan screw to tap a thread into the side panel. This method works well with the Metis' aluminium panel, as it's fairly soft. You can then fit the fan grille.

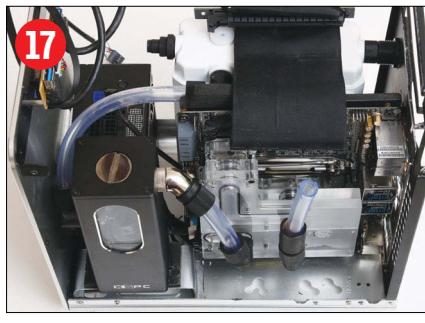
11 REMOVE MOTHERBOARD HEATSINKS

You'll need to remove both blue heatsinks on the PCB in order to fit the waterblocks. They're simply secured underneath using screws. You can then apply the included thermal pads to the VRMs and a small amount of thermal paste to the chipset.

12 FIT WATERBLOCKS

With this setup, two waterblocks sit underneath pass-through section. The CPU





waterblock secures using standard sprung thumbscrews. Attach the four seal fittings into the tops of the waterblocks, making sure they're tightly screwed in place. It's worth installing your M.2 SSD and case cables before you mount the top section too.

13 FIT PASS-THROUGH

There are no screws involved in this job – the pass-through section simply presses into place, and is secured and sealed by O-rings on the four seal fittings.

14 APPLY NEOPRENE SUPPORT

The rear bracket isn't strong enough to hold long cards, such as our GTX 980 Ti, in place without support from a PCI-E connector mounted on a motherboard. A few layers of adhesive neoprene stuck on top of the motherboard tray will keep the card in place.

15 INSTALL PUMP

Remove the protective film on the pump mount you made earlier, then press the pump in place. Along with the tubing connected to the pump, this adhesive will be strong enough to hold the pump in place and reduce vibrations too.

16 INSTALL RADIATOR

Secure the Noctua 140mm fan to the radiator then place the radiator into the case. Secure it to the drain port at the rear of the case, which will hold it in place, so there's no need to use any other mounts. Be sure to use the correct ports on the radiator – image 16 shows how *not* to plumb it in, with fittings connected to the same side. You need to place one fitting on the other side next to the drain port.

17 INSTALL MOTHERBOARD AND FITTINGS

Install the PSU connectors and memory to the motherboard, then fit it in the case.

18 FIT PCI-E RISER CABLE

With the graphics card installed, run the PCI-E riser cable from the motherboard, underneath the graphics card and fix it to the card on the other side. Lock both connectors in place using the standard lever arms.

19 SECURE CABLE

There will likely be a length of spare PCI-E riser cable dangling out the side, which can be secured out of the way using cable

ties. Be careful not to apply too much pressure, as the connectors can be delicate.

20 CONNECT TUBING AND LEAK TEST

You'll need to make sure the tubing is free from kinks in such tight confines, and it's worth checking for these kinks once the system has warmed up and the tubing is more flexible. If they occur, they can kill your flow rate, so use anti-kink springs if you encounter them. With the roof and side panels still detached, fill the system, then power up the pump using a PSU jump adaptor so that the fans and pump start, but the hardware isn't powered. This way, if your system does leak, you can simply dry off the hardware and identify the leak. To leak-test, add some dye to your coolant, and place tissue paper over the joins in your loop. Leave it running overnight, and you'll be able to identify any leaks from coloured tissue paper.

21 REINSTALL CASE PANELS

Once you've leak tested, install the case panels. One of the benefits of the Metis is that it's so easy to dismantle – removing the roof, front and side sections gives you access to the entire PC and water-cooling system.

PERFORMANCE AND OVERCLOCKING

Before we started overclocking, it was important to see how our radiator coped with cooling the Core i7-5960X and GTX 980 Ti. Running Prime95's smallfft test and Unigine Valley at the same time for 15 minutes, we saw the CPU top out at 74°C, with a delta T of 51°C using the motherboard's standard CPU fan profile. This temperature indicates reasonable headroom for an overclock. The GPU, meanwhile, sat at 57°C, with a delta T of 34°C – again, a long way from the GTX 980 Ti's thermal throttling limit of around 80°C.

Our maximum Core i7-5960X frequency is around 4.45GHz with a 1.35V vcore. However, this overclock requires elaborate cooling and we need to cool a GTX 980 Ti too. As such, we decided to hit 4GHz with a vcore of 1.25V, using the OC Tweaker section in the motherboard's EFI system. At stock speed, the system score of 165,420 was already much faster than the average scores we see from Z170 systems, which usually sit around 135,000. In fact, even with a Core i7-6700K overclocked to 4.8GHz, we rarely see a system score higher than 150,000.



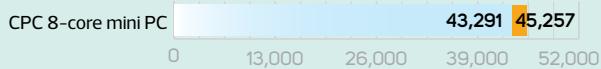
Overclocking saw this rise to 179,689. You really see the performance benefit of the 8-core CPU in our heavily multi-threaded video encoding test.

Gaming at 3,860 x 2,160 proved to be no issue for our system either, with minimum frame rates above 30fps across the board in our game tests. We had to run Fallout 4 at High rather than Ultra setting here, but it still looks great. We saw handsome gains from overclocking in MSI Afterburner too, where we boosted the GPU core by 200MHz and the memory by 250MHz (1GHz effective). The lowest minimum frame rate at 4K then sat at a healthy 36fps in Crysis 3.

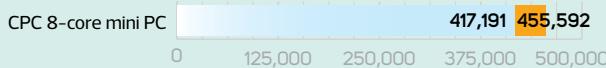
Meanwhile, power consumption sat at 280W with just the CPU under load, rising to 385W if we loaded the GPU with Unigine Valley at the same time. Once overclocked, Prime95 saw the system draw 354W loading only the CPU, but with Unigine tagged on as well, the load system power draw rose to 545W. With the CPU temperature rising to 86°C as well when the GPU was also loaded, it's clear that, even though these figures come from slightly unrealistic 100 per cent load tests, these settings will be the limit as far as overclocking goes in terms of both thermals and our PSU's 600W limit. **CPC**

CPC REALBENCH 2015

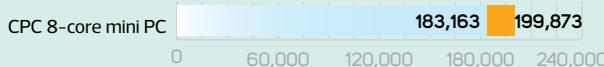
GIMP IMAGE EDITING



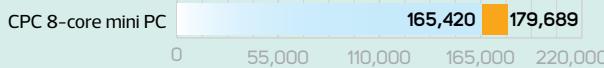
HANDBRAKE H.264 VIDEO ENCODING



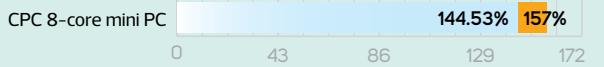
HEAVY MULTITASKING



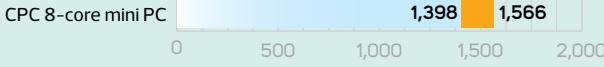
SYSTEM SCORE



INTEL REFERENCE



CINEBENCH R15

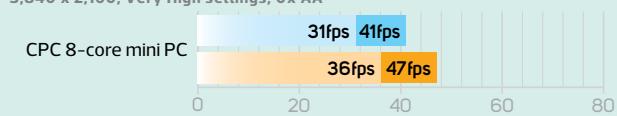
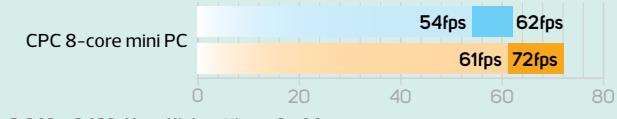


POWER CONSUMPTION



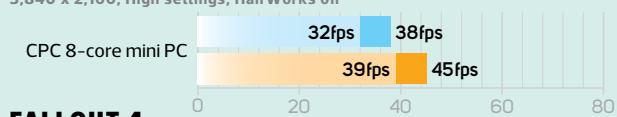
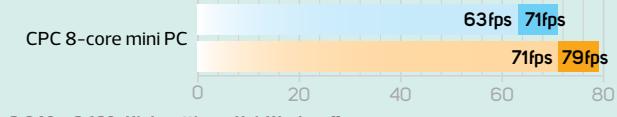
CRYYSIS 3

2,560 x 1,440, Very high settings, Ox AA



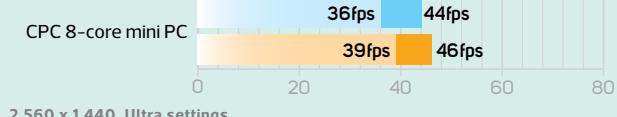
THE WITCHER 3: WILD HUNT

2,560 x 1,440, High settings, HairWorks off

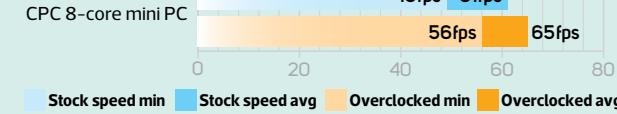


FALLOUT 4

3,840 x 2,160, High settings



2,560 x 1,440, Ultra settings





The RAPID RISE OF eSPORTS

Over the past five years, the phenomenon of eSports has exploded, becoming a multi-million pound industry and transforming the gaming spectrum. Rick Lane investigates

On 18 June 2015, Wembley Arena was packed out. Originally built for the 1934 Olympics, and host of the 1948 and 2012 Olympic swimming competitions, the Arena was now centre stage for an entirely new kind of sporting event. Tens of thousands of fans gathered to watch the quarter final of the League of Legends (LoL) World Championships, while millions more watched the showdown online via Twitch. Even the BBC streamed the event for UK audiences, the first time a mainstream broadcaster has done so for an eSports competition.

In total, 36 million people watched 16 teams compete for a combined prize purse of over \$2 million US. Alongside Wembley, the championship packed out arenas in France, Belgium and Germany. The winners of the tournament, the South Korean team SK Telecom T1, took home a grand prize of \$1 million.

It's only the fifth year the LoL world championship, known as the LCS, has been running, and it isn't even the largest prize in eSports.

At the Dota 2 International championship last year, the US team Evil Geniuses took home \$6.5 million, roughly twice as much as a Wimbledon champion.

The phenomenon of eSports – where games are played competitively for prestige and increasingly lucrative prizes, has been growing steadily since the late 1990s. Around 2010, however, that growth exploded, and hasn't stopped exploding. Games such as League of Legends, Dota 2, Counter-Strike and Mortal Kombat X have their own official leagues and tournaments, matches can attract online audiences of millions, while major live events see attendances that pack out arenas and even stadiums.

Once an enthusiast subsection of gaming, eSports is now well and truly an established industry and it's set to grow further. 'This year is the birth of eSports,' says Michael O'Dell, managing director of Team Dignitas, one of the UK's oldest eSports teams. 'The past 16 years have been laying the foundations.' With this newfound power,

however, comes increased responsibility. The eSports arena may be a mighty force in the gaming world, but it's currently largely unregulated, and its complex, amorphous structure means it isn't always clear who exactly is holding the reins.

THE BEGINNING

O'Dell, who goes by the nickname Odee, has been with Team Dignitas since its formation in September 2003, and was an avid eSports player for several years prior. O'Dell originally got into eSports by playing Quake, and between 1999 and 2001, was playing the highest division of Quake's main eSports league. Then, in 2002, Battlefield 1942 was released, a game with large islands that combined vehicular and infantry combat. 'I still remember playing it and flying around in a Japanese plane trying to loop under a bridge,' O'Dell says. 'It was just amazing.'

Having become hooked on Battlefield, O'Dell decided he wasn't making enough money playing Quake, so he started his own Battlefield team. After a while, he and his two best British players approached a German team called Legion Condor, and were allowed to join. Then, due to a shortage of professional players, Legion Condor merged with a Swedish team called Sweden Kompanix, forming Team Dignitas. O'Dell was eventually appointed head of Dignitas after the company acquired its first sponsorship deal of \$10,000 US. 'I wanted to be in the best team in the world at this game, because I just knew I had the drive, potential and skill, that arrogance to be the best. That's what the top players have—they know they're good,' O'Dell says.



The world of eSports in the early 2000s was very different to now. Even in Korea, which many consider the spiritual home of eSports, the first official StarCraft tournaments were only held in 2002. In the West, the vast majority of the early eSports community was online. The main league for shooters such as Quake and Half-Life was run by a website called Barrysworld, which O'Dell describes as 'the Sunday league of eSports'. There was a smattering of live tournaments, such as those held at QuakeCon in Dallas. 'I helped to get some Quake players to QuakeCon, because they couldn't afford it, and I had a job, so I was lending them money to just get them to QuakeCon,' O'Dell explains. 'I don't think it was even called eSports then, to be honest.'

BIG MONEY

For its first few years eSports was a hobby. Individuals such as O'Dell competed for prestige more than prizes, and there was little support or organisation from sponsors or other external sources. 'Everybody dreamed of earning money in a tournament,' O'Dell says. 'I didn't leave my full-time job until 2006, and that was only when we'd picked up more sponsors.'

Now, Team Dignitas is a much larger and more complex beast, to the

The LCS quarter final sold out Wembley Arena last year

point where the very word 'team' is a little misleading.

Unlike, for example, a football team, Team Dignitas comprises multiple teams and individuals from all over the world, all of whom compete in different games. Team Dignitas has signed professional players for games including Counter-Strike, League of Legends, Hearthstone, StarCraft II, FIFA and Trackmania. 'There are careers now,' O'Dell says. 'You join Dignitas now as a player, you're going to get paid a fee. And some of the teams get paid really well.' Indeed, O'Dell believes it won't be long before he signs his first player on a million-dollar contract.

TEAMS AND TOURNAMENTS

The way Team Dignitas is structured gives you an insight into the convoluted organisation of the eSports world. In some ways, it isn't altogether different from regular sports. Each game is a different sport in its own right. FIFA is to football what League of Legends is to rugby, Counter-Strike is to archery, Hearthstone to professional poker and so on. However, the delineation between who organises and who competes in these eSports is less clear-cut. Some companies such as Valve will administrate and organise tournaments, such as The International, entirely in-house. The International is Dota 2's official tournament, and it currently has one of the largest prize pools in eSports. For others, the organisation occurs between multiple organisations, including the game developers or publishers, broadcasters and the players themselves.

One of the largest such organisations is the eSports League Gaming Network (ESL). Founded in 2006, The ESL organises eSports





Counter-Strike is one of the longest-running games to have an eSports scene. The latest iteration, Global Offensive, was geared specifically towards pro-gaming

leagues and tournaments on behalf of developers and publishers, including the Intel Extreme Masters, which is the highest-level of eSports tournaments for games such as League of Legends, Counter-Strike and StarCraft II.

Joshua Gray is a producer at ESL, whose job involves organising these leagues and tournaments. 'If a publisher or developer wants to partner with us and create a league surrounding their game, and we feel that it's appropriate enough to create a league around it, we work together to accomplish that,' he says.

The ESL organises its leagues using several general tiers. At the top is the ESL One, the eSports equivalent of a champions league. 'These are events that fill stadiums, primarily in Europe,' Gray explains. Below ESL One are the ESL Pro leagues, which comprise regular weekly matches that are broadcast online in seasons that last around eight weeks for most

games, although major eSports such as Call of Duty can have considerably longer seasons. Then, at the bottom is what the ESL calls the Go4 system, which is akin to a Sunday league structure, with small prize pools and no barrier to entry.

'In each of these different tiers, we'll find what's appropriate for the game itself. If the game is just starting out, if it doesn't have a big eSports footprint in the world, if they're just trying to gauge interest and see if people are ready to play at a competitive level, then we can enter the game into one of our Go4 systems,' Gray says. 'If the game is definitely viable, definitely has eSports potential and the community is clamouring for it, then we can create a Proleague around the game and create a system where competitors play every week, at the same time.'

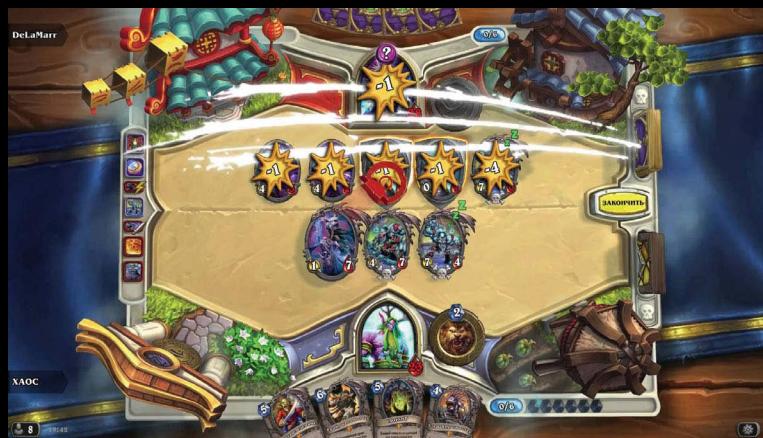
Both the Go4 and Pro leagues have their matches played online, but the Proleague has an additional element.

At the close of a season, the top four or five players in that league are then entered into the finals, a tournament-style setup used to conclude the season. 'We fly the players to the finals at one of our studios, or to an off-site location, or one of the big trade shows around the world,' Gray says. 'They'll usually win thousands of dollars if they win first place. It depends on the game, the prize breakdown and the format.'

Finally, there are the major annual tournaments, such as the Intel Extreme Masters. These events are the closest eSports has to a World Cup, although some of the larger developers, such as Riot Games and Valve, run tournaments for their own games. Either way, these huge live events are a particularly intriguing aspect of eSports due to their physical element, with an atmosphere equivalent to a major sports match or rock concert.

BROADBAND OF BROTHERS

In many ways, these events are organised in a similar fashion to any other large, public event, although there are a few extra considerations, the primary one being broadband. 'Even when you're playing somebody sitting right next to you, you have to connect to the Internet,' Gray says. 'With the technology and expectations we have today, and with publishers trying to fight against piracy, it's always connected and always on, so we have to make sure that venues can accommodate that at speeds that will



With its fairly simple rules and community-friendly design, Hearthstone has proved a popular entry-level eSport



The International, Dota 2's official tournament, currently has one of the largest prize pools in eSports

have next to no latency for players. That's always something that we have to be very concerned about.'

The importance of fibre-optic broadband to eSports can't be underestimated. Not only does it make these fast-paced games that are exciting to watch possible, but it also makes broadcasting them possible via live-streaming services such as Twitch. The advent of live streaming was a huge boon for the Sports world, as it didn't have to rely on the grace of conventional media networks in order to thrive. 'Almost every major media company, almost every major player in the space of entertainment, is coming to us, and asking "how can we work with you?"' Gray says.

REFEREEING

While the Internet is undoubtedly the lifeblood of eSports, the fact that the bulk of eSports are still played remotely online also creates some unique problems. One of these problems is 'refereeing' matches, although with eSports it's more like 'administrating' matches. Like any competitive event, eSports will encounter some players who try to cheat or game the system and, unlike a tennis match or a chess game, there usually isn't a referee physically present to mediate. The ESL approaches this problem using a unique system that resembles the solution to both a technical support query and a legal dispute, which Gray describes in relation to the fighting game Mortal Kombat X.



The crowd at the 2015 Intel Extreme Masters in Katowice, Poland

'Let's say one of your opponents faces you just in one game, then they leave, take off and you wait but they never come back. You submit a ticket saying, "Hey, I just won one round but they never came back," and you submit it to the admin. However, your opponent submitted a different ticket, saying: "Well I beat the guy three zero." So now you have a conflict,' Gray says. In the rules set down by the ESL, players are strongly encouraged to screenshot or record their matches, especially when something goes

awry. The player with the evidence will proceed to the next round, while the player without evidence will be knocked out of the tournament.

Another issue unique to eSports is the highly fluid nature of the games themselves. Developers are constantly tinkering with the systems that underpin their games, making particular units stronger or weaker, adding new mechanics and removing redundant ones. Rules can change in regular sports as well, but nothing like the extent to which eSports flow and



Blizzard's upcoming team-based multiplayer shooter Overwatch is one of Team Dignitas' most anticipated games



While Street Fighter is more obviously designed with eSports in mind, Mortal Kombat X has proved a popular choice for ESL viewers

alter and evolve. When asked about how, as an eSports player, you respond to these changes, Michael O'Dell's response is straightforward. 'Practice,' he says. 'All games have a slight change every now and then, and you practise with the new changes. You look at the knock-on effects.'

REGULATION

While the changeable nature of eSports games doesn't bother O'Dell that much, he's concerned about a broader problem that's becoming more and more apparent – regulation. 'There's still no regulation in many of the games. We're self-governing to a point, so a lot of the big teams work together on lots of issues but we still don't have governing bodies or anything like that,' he says.

Some companies, such as Riot Games, make a concerted effort to govern their own games, creating clear and strict rules, and enforcing them consistently. However, for many games, rules only apply to the game itself, and not to the wider issue of how the sport is conducted. One of the major issues that concerns O'Dell is player poaching, where one team will attempt to convince a player from another team to join them, sometimes during competitions.

In 2014, Counter Logic Gaming was fined \$10,000 by Riot for attempting to poach William 'Scarra' Li from Dignitas' League of Legend team. Last year, Riot actually banned the owner of US team Misfits from entering its annual championship until 2017, for repeated attempts to poach players from other teams.

An even more serious concern within eSports is doping. In the last couple of years, several pro-gamers



Riot Games' League of Legends is perhaps the world's most popular and best regulated eSport

Some games, such as Rocket League, just scream eSports potential



much more rigid structures in place to deal with it. Nevertheless, it's best to ensure the right safeguards exist before the problem becomes too endemic. Hence, in a way, it's even more imperative that the eSports communities ensure proper anti-doping regulations are in effect and enforceable.

The eSports world is only going to grow in terms of audience and revenue, so the need for appropriate regulatory bodies is only going to become more vital. O'Dell points out that acquiring a Dota 2 team for Dignitas would easily set the company back \$250,000, and a League of Legends team, if he didn't already have one,

would set him back considerably more. The big entry fees and bigger prizes are even starting to attract conventional sports teams to the eSports sphere. 'The Sacramento Kings bought a team. Rick Fox, who used to play for the LA Lakers, bought a team. There will be more this year for sure,' O'Dell says.

ESPORTS IN THE UK

As for the UK eSports scene, O'Dell is concerned that the country is lagging behind a little, citing a lack of support from sponsors despite some pretty significant tournaments. 'We're still slightly seen as kids in their bedrooms playing games,' he says. 'There are lots of tournaments, such as ESL UK, Multiplay and so on, but the UK still isn't looking at those tournaments as big-ticket items. I don't get it, because lots of people watch those tournaments in this country. Seeing Wembley Arena sold out last year was amazing – the fans are there.'

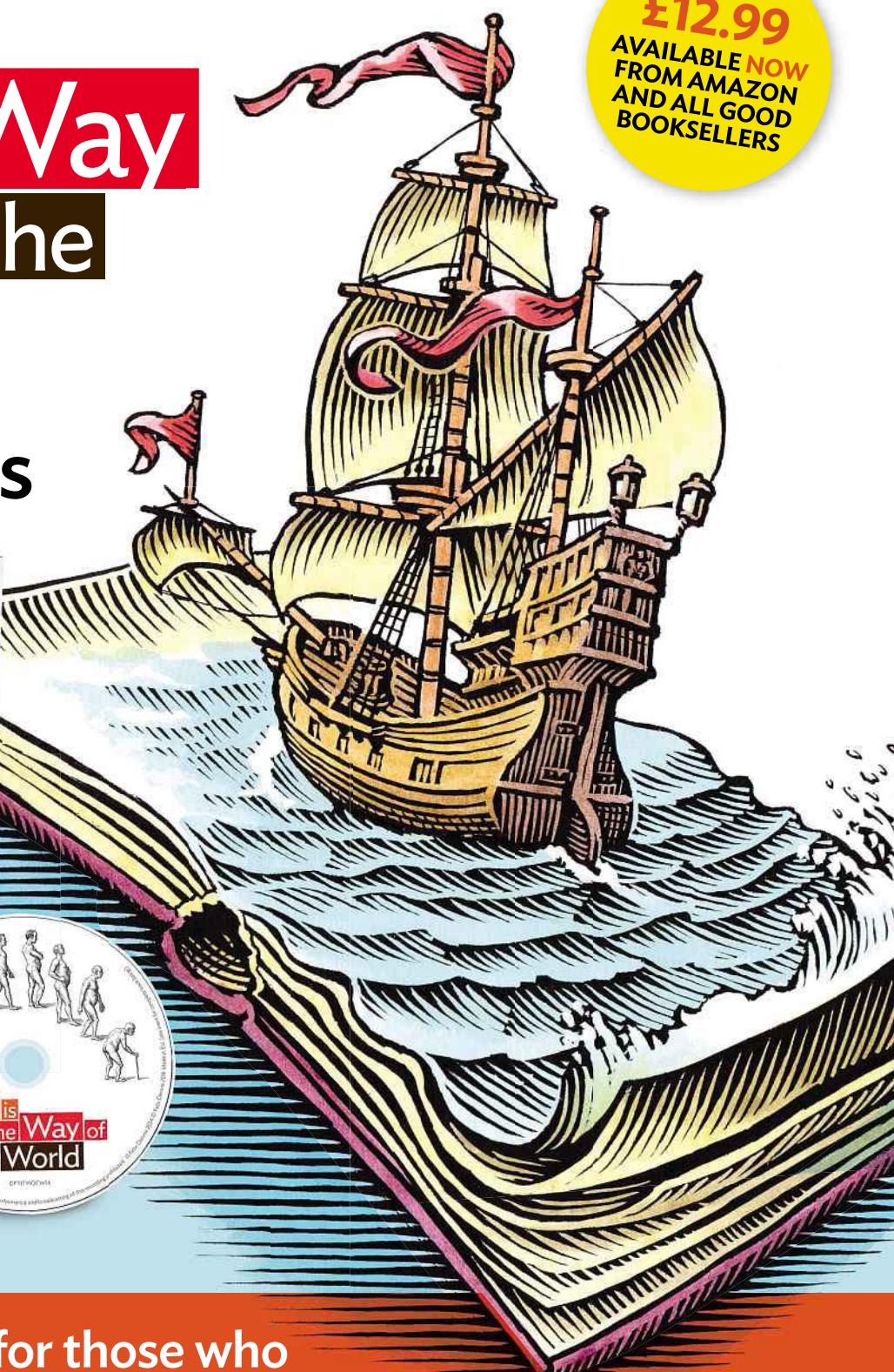
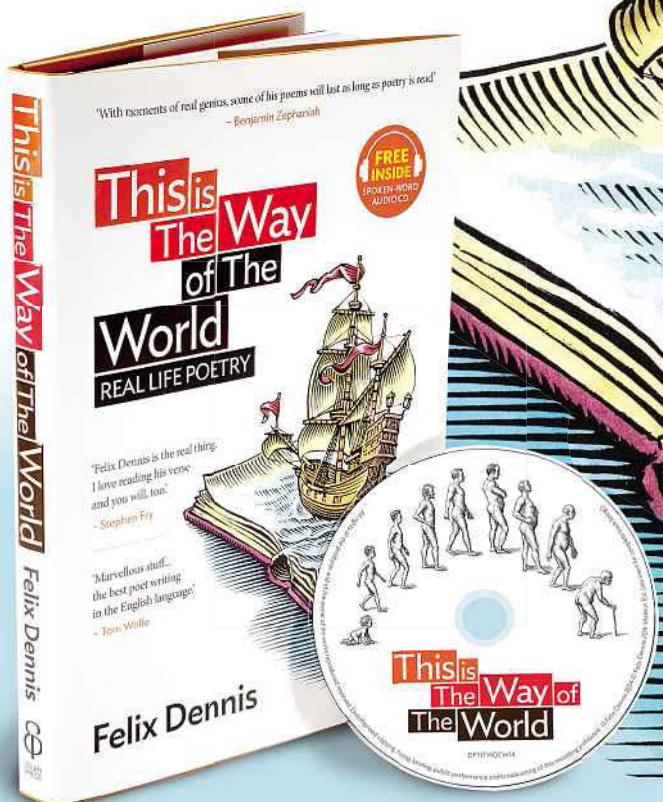
O'Dell hopes to see more support from government bodies and sponsors in the future. He doubts the scene will see much verification from conventional sports bodies and organisations, but he doesn't see this issue as important. 'eSports is totally different, and it's not going to get smaller – it's just going to get bigger,' he concludes. **GPC**

'With moments of real genius, some of his poems will last as long as poetry is read.'

– Benjamin Zephaniah

This is The Way of The World

Felix Dennis



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A collection of 'real life' poems by Felix Dennis, one of Britain's best-loved poets, charting life's course from infant to endings with illustrations by Bill Sanderson.

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GARETH HALFACREE'S

Hobby tech

The latest tips, tricks and news in the world of computer hobbyism, from Raspberry Pi, Arduino and Android to retro computing

REVIEW

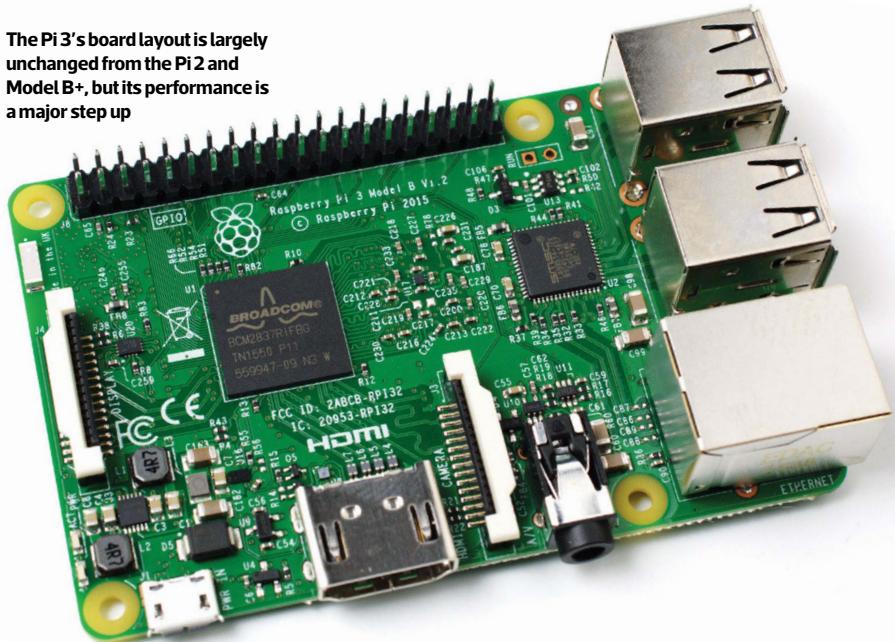
Raspberry Pi 3

With a first glance at the Raspberry Pi 3, the silkscreen layer aside, you could convince yourself that you're holding a Raspberry Pi 2, or even a Raspberry Pi Model B+. It's all there: the 40-pin general-purpose input-output (GPIO) header, the four USB ports, the system-on-chip processor slap bang in the centre, even the rounded corners and mounting holes. Physically, the Raspberry Pi 3 is definitely underwhelming.

That is, until you realise what this consistency means: the Pi 3 is a complete drop-in replacement for the Pi 2 or Model B+ in any existing project. If you own any add-on hardware, it should work just fine with the new device, bar a few hiccoughs regarding the decision to switch over a couple of UARTs, which could cause temporary problems for devices that communicate via the GPIO header's serial port. In short, the fact that the Pi 3 isn't dramatically different to its predecessors is a definite plus.

For those eager to get to the meat, there are some negatives. If you're running out of RAM, you'll find no aid from the Pi 3, with its Pi 2-matching 1GB. If you were hoping for USB 3 support, you're going to be disappointed, and there's still no sign of any of the extras offered by rival boards either, such as an

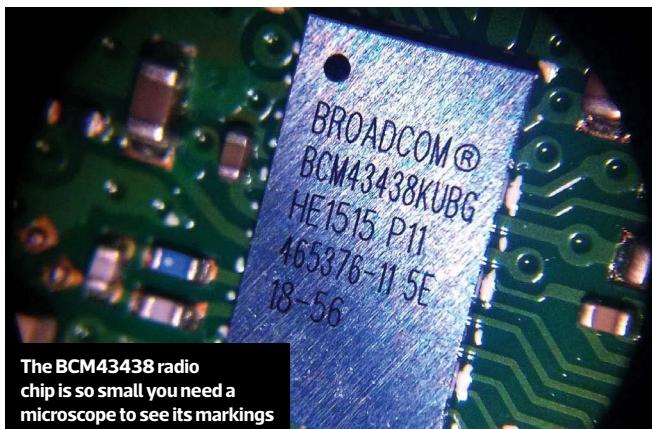
The Pi 3's board layout is largely unchanged from the Pi 2 and Model B+, but its performance is a major step up



on-board microcontroller, SATA support or an M.2 port. The Broadcom VideoCore-IV graphics processor also remains intact, although running at a stock frequency of 400MHz compared with the original 250MHz clock speed.

So, on to the positives: the Pi 3 is fast. Not desktop-fast, of course – we're still talking

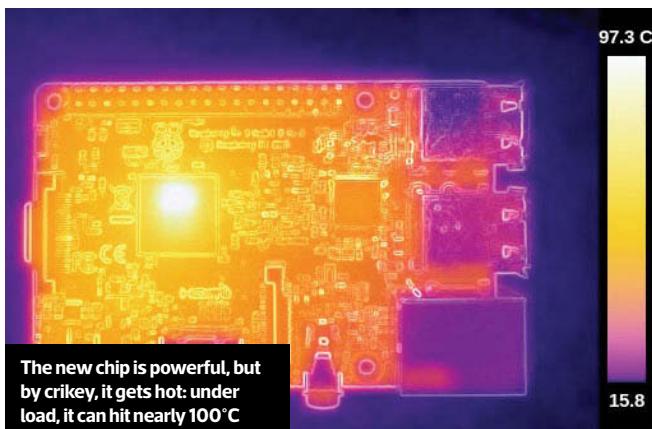
about a sub-£35 device that draws just 0.58A from its 5V power supply under heavy load – but compared with its predecessors, it's fast. The new BCM2837 processor ditches the ARMv7 32-bit cores of the Pi 2 in favour of four 64-bit Cortex-A53 cores running at 1.2GHz. The results are immediately obvious: the Pi 3 completes a SysBench multi-threaded CPU



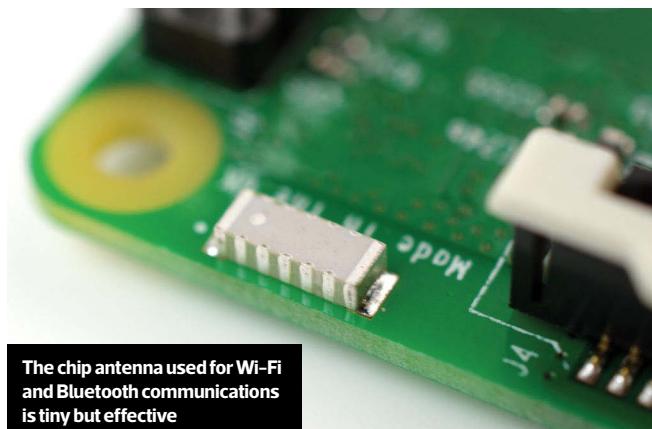
The BCM43438 radio chip is so small you need a microscope to see its markings



The Pi 3's new BCM2837 system-on-chip boasts 64-bit Cortex-A53 processing cores running at 1.2GHz



The new chip is powerful, but by crikey, it gets hot: under load, it can hit nearly 100°C



The chip antenna used for Wi-Fi and Bluetooth communications is tiny but effective

test in just over 49 seconds, compared to the Pi 2's 76.28 seconds, both of which leave the Model B+'s 510.81 seconds in the dust.

The story is the same throughout all the benchmarks I could throw at it the Pi 3. The CPU scores 193.36 MFLOPS on the classic Linpack single-precision benchmark, rising to 459.18 if you compile with NEON SIMD support, while the Pi 2 scores 156.81(296.48 with NEON) and the Model B+ just 55.54 (and there's no NEON support on the B+). Memory throughput is also higher at 304.61MB/sec for 1KB reads and 304.61MB/sec for 1KB writes, compared to the Pi 2's 190.48MB/sec and 227.38MB/sec, and the Model B+'s 96.69MB/sec and 139.23MB/sec respectively. Even games get a boost: the classic Quake III Arena timedemo hit an

average of 70.1fps on the Pi 3, compared to 57fps on the Pi 2 and just 19.4fps on the Raspberry Pi Model B+.

So it's faster, but that isn't the main selling point. The Pi 3 brings a feature for which fans have been clamouring since the launch of the original Model B four years ago: wireless networking. A Broadcom BCM43438 radio chip is located on the rear of the board, although it's easy to miss, which brings 2.4GHz 802.11n Wi-Fi, Bluetooth 4 Classic, and Bluetooth Low Energy to the table. Interestingly, the chip also includes an FM radio receiver; sadly, though, it's left disconnected on the board itself.

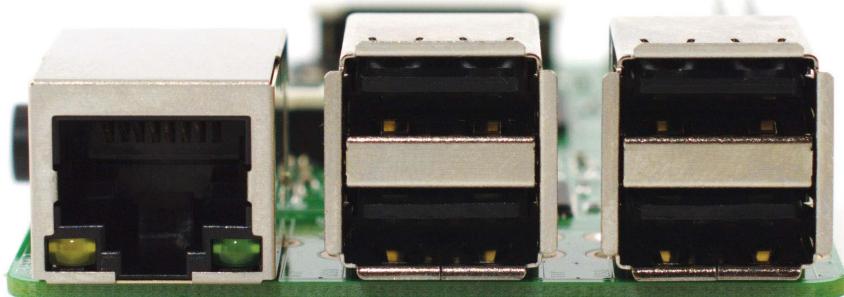
Despite connecting to a tiny chip antenna at the upper-left of the board, the radio was more than capable of picking up my home

Wi-Fi through three floors of the building -- although the lack of a u.FL connector, for which a pad is included on the bottom, means that you'll need to be handy with a soldering iron if you do need to add an external antenna. Bluetooth works as expected too, although unless you're comfortable fiddling at the console, you'll want to install a graphical tool such as Blueman to manage it.

There's a hidden pitfall in the claims of 64-bit support though: while the BCM2837's CPU cores are indeed based on the 64-bit ARMv8 Cortex-A53 processors, they're used in 32-bit mode exclusively. The Foundation has indicated that this restriction may change, but for now, you're not getting the most out of the chip.

The new SoC design gets toasty too: under load, it hit a peak temperature of nearly 100°C in a 16°C room, although the internal temperature sensor never registered above 80°C, oddly. To its credit, the Pi 3 was unfazed by this extreme temperature, but if you're planning to house the device in an enclosed space, I'd recommend using a small heatsink and some ventilation, making it the first Pi model to really warrant such a recommendation.

The Raspberry Pi 3 is available now from <http://cpc.farnell.com> for £31.66 inc VAT, under the product code SC1401241.



Sadly, the Pi 3 still has the same four USB 2 ports and 10/100 Ethernet as its predecessor, all communicating over a shared USB channel

TUTORIAL

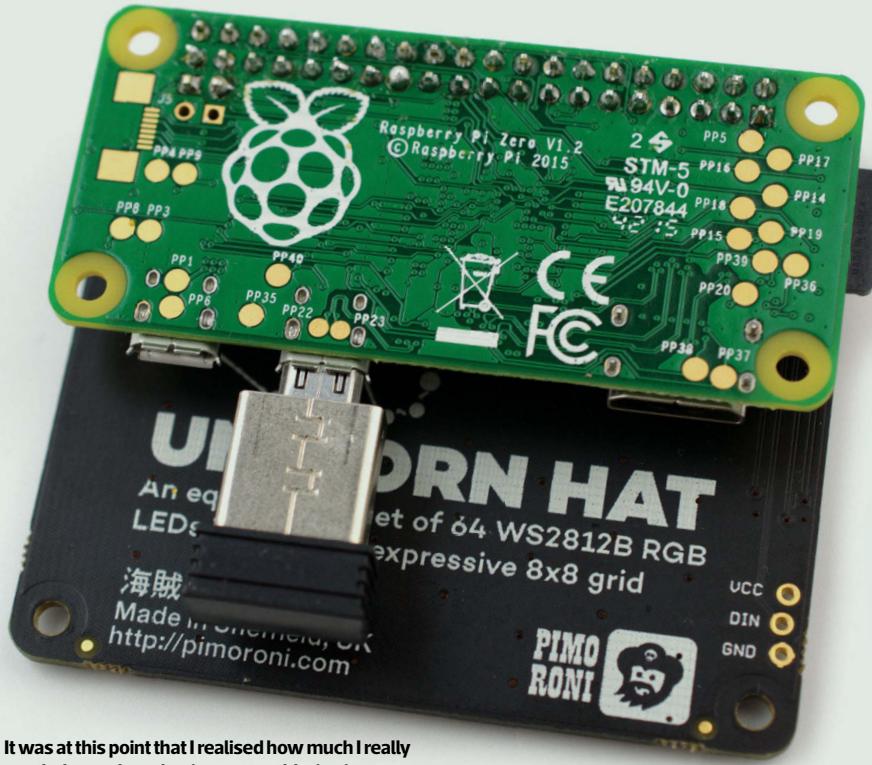
Raspberry Pi Zero electricity usage graph

Having signed up for a Loop energy monitor, which promised to give me insight into my gas and electricity usage over time, I was disappointed to find there was no publicly accessible application programming interface (API) for polling the data. A kindly customer service person pointed me to a third-party hack that was capable of pulling down the raw data, although with the warning that it was entirely unsupported and could go away at any given moment without warning.

And at that point the idea was born. I wanted to make a pretty real-time graph of electricity usage, in an effort to remind others in the household to turn off devices when they're done with them. Using a Raspberry Pi Zero for this job is admittedly overkill, but I've also got it churning through previously unbroken Enigma ciphers from World War II, courtesy of www.enigmaathome.net, so its processing power isn't completely wasted.

What you'll need

- Loop energy monitor – £45 inc VAT (or £2.99 monthly)
www.your-loop.com
- Raspberry Pi – from £4 inc VAT
<https://shop.pimoroni.com>
- Unicorn HAT – £24 inc VAT
<https://shop.pimoroni.com>
- Wi-Fi dongle (optional) – from £1.75
www.aliexpress.com
- Box frame (optional) – £7
www.amazon.co.uk



It was at this point that I realised how much I really needed to replace the tip on my soldering iron...

1 Install an energy monitor

I'm using a Loop here, but technically speaking, this tutorial isn't about monitoring energy at all; it's about graphing incoming data onto the Unicorn HAT. Anything you can feed into the Pi as a number can be used as data, but it just happens that I'm using the Loop to track electricity usage. If you're buying a Loop – or a rival clamp-style energy

monitor – install it according to the instructions, and check to make sure you're getting good data in the official software before messing around.

2 Get raw data

Getting raw data out of the Loop isn't that straightforward. There's no API, although the company is reportedly investigating offering an API in the future, but a clever chap called Marcos Scriven has written a Node.js-based tool that can pull down data as a JSON string – machine-readable, but relatively easily stripped for human consumption. Grab the software from <https://github.com/marcosscriven/loop> and install it on your Raspberry Pi according to the instructions, then run it and make sure you're getting data in regular ten-second intervals.

3 Format raw data

The JSON data that comes from Scriven's program isn't particularly friendly, and we want to avoid hacking around in Python to strip out the excess, which is where the GNU/Linux command line comes to our rescue. Run the following command in the terminal, all in a single line:

```
nohup node node-loop.js | gawk -F
```

```
blacklaw@trioptimum:~$ readinglist = [0,0,0,0,0,0,0,0] # Initialises the list of readings for graphing.

while True:
    readingfile=open('/tmp/electricityreading.txt', 'r')
    rawreading=readingfile.readline() # Get the latest reading
    readingfile.close()
    reading=int(rawreading) # Convert string into integer.
    readinglist.insert(0,reading) # Insert reading at the start of the list.
    del readinglist[8:] # With an 8x8 matrix, we only want eight list entries.
    for x in range(8): # Run through all eight X axis positions.
        for y in range(8): # Graph each Y axis entry based on gradient size.
            readingcomparison = (y+1) * gradients
            if (readinglist[x] >= readingcomparison):
                if (y < 2):
                    UH.set_pixel(x,y,255,0) # Green for bottom two LEDs.
                elif (y >= 2) and (y < 4):
                    UH.set_pixel(x,y,255,255,0) # Yellow for next two LEDs.
                else:
                    UH.set_pixel(x,y,220,20,60) # Red for top four LEDs.
            else:
                UH.set_pixel(x,y,0,0,0) # Turn LEDs above our reading off.
    UH.show() # Update the display
    time.sleep(10) # node-loop.js updates every 10 seconds, so wait a while.
40,1 Bot
```

There's a trick to making a scrolling graph on a Unicorn HAT, as it has no built-in scrolling feature

Each LED corresponds with 200W of use, and the display updates every ten seconds; try turning on the kettle to see the impact!

```
'[,:]' '{print $11;fflush();}' | xargs -n 1 -I'{}' sh -c 'echo $1 > /tmp/electricityreading.txt' -- {} &
```

I have no problem admitting that I needed some help with this step. This line passes the output of Marcos' program through Gawk to print only the field we need, which is passed to xargs in order to write it to a file in /tmp a single value at a time. The result is that there's a single electricity usage reading, in watts, stored in the file called electricityreading.txt at any given time.

4 Graph formatted data

So we now have a text file with a number in it. Now, we need to graph it. Install and test the Unicorn HAT software from Pimoroni, if you haven't done so already, then execute the following:

```
wget -O loopi.py tinyurl.com/loopi-py
```

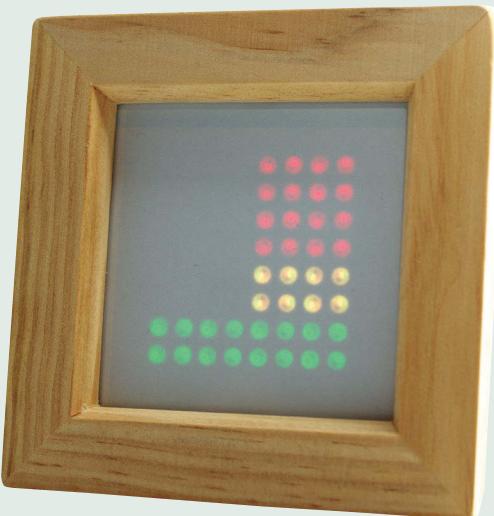
Install gawk:

```
sudo apt-get update && sudo apt-get install gawk
```

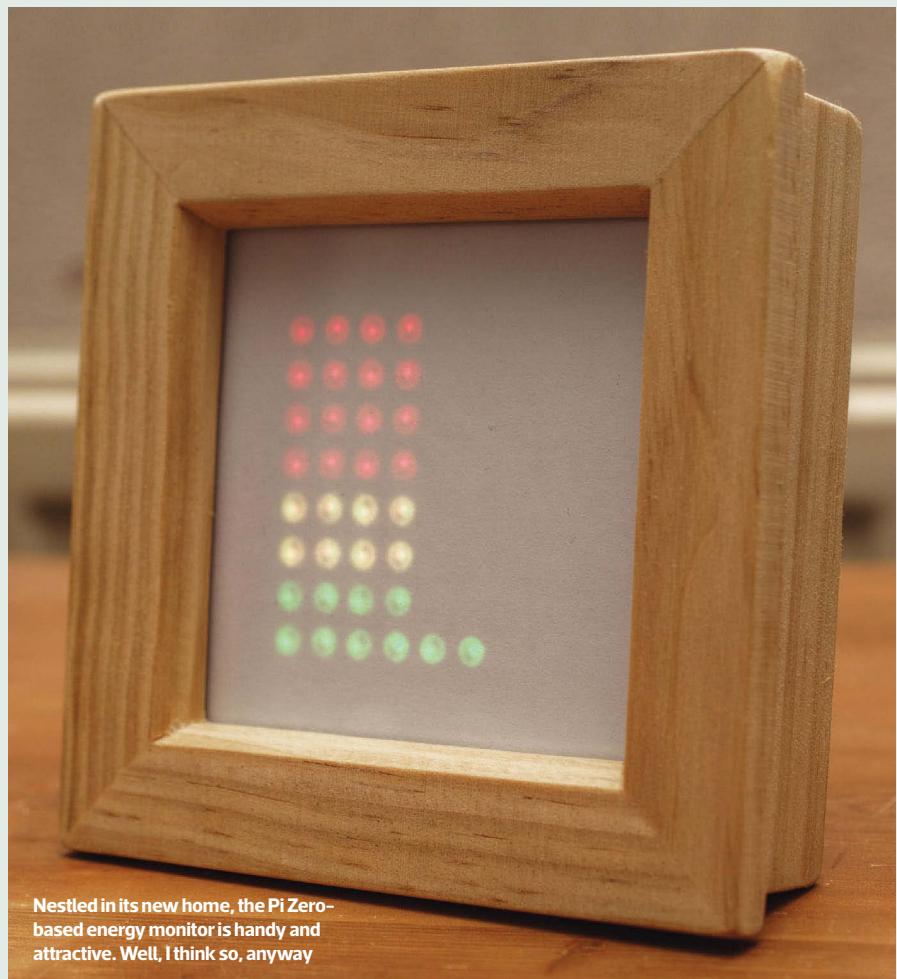
Then run the program:

```
sudo python loopi.py
```

All being well, your electricity readings should scroll across the Unicorn HAT. Each LED corresponds with 200W of use, and the display will update every ten seconds; try turning on the kettle to see the impact!



Installing the energy monitor into an attractive box is optional, but well worth your time



5 Stick it in a pretty box

Finally, and optionally, you can make the energy monitor look a little less like an eyesore by sticking it in a pretty box. Naturally, you could use a Raspberry Pi case for this job but if, like myself, you're using a Pi Zero with a wireless dongle, you'll find it fits neatly inside a cheap wooden box frame. Secure the Pi Zero and Unicorn HAT to the box frame with

hot glue or, if you want to get it out in the future, Blu-Tack, and cut a hole in the rear of the frame for the power cable. To diffuse the LEDs a little, place one or two sheets of white paper between the Unicorn HAT and the glass. For an even fancier effect, pick up some one-way mirror film and coat the glass of the frame; when the LEDs are off, your box will have a plain mirrored surface.

NEWS IN BRIEF

Cool Components hit by data breach

Hobbyist supply specialist Cool Components has had its email database – and possibly more – snaffled and provided to competitor RoboSavvy. Customers have found themselves in receipt of emails from RoboSavvy, sent to addresses provided only to Cool Components, but the latter company claims its investigations have turned up no security issues.

RoboSavvy has denied purchasing email lists, claiming an unknown third party in China mass-subscribed the Cool Components database to the RoboSavvy mailing list for unknown reasons. Cool Components customers are advised to contact the company for information about the breach, and to change their password as soon as possible.

INTERVIEW

James Adams

I catch up with the Raspberry Pi Foundation's director of hardware

It takes a sizeable team to produce the Raspberry Pi, but its design is led by one man: James Adams, director of hardware at the Raspberry Pi Foundation. 'Initially with the B+ design, [the difficulty] was how to re-engineer the Pi within budget and without losing the DNA and iconic design cues of the first version,' he explains of his first major project with the Foundation. 'I started from scratch and worked hard to make it as good as possible. I've always been very proud of the re-engineered form factor.'

'Pi 2 was a big challenge, as we had to work with Broadcom to re-engineer the BCM2835 processor into the BCM2836. One of the largest challenges was squeezing in the memory interface. I had to re-engineer it to get the memory chip closer to the processor, as the Broadcom reference design had the memory chip too far away to fit the two parts onto the Pi board.'

Now, Adams' work can once again be seen in shiny new Pi 3, which brought its own set of challenges to the table, not least of which was the inclusion of a radio module for the first

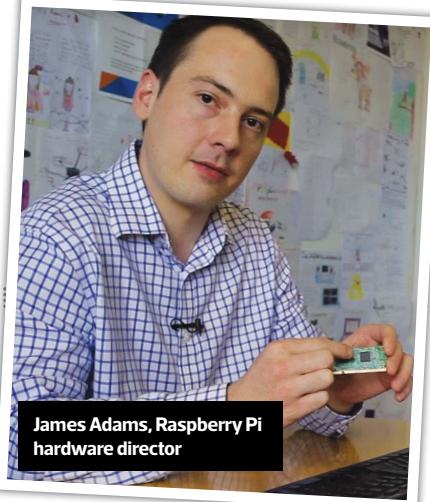


Adams is responsible for cramming the radio module onto the already packed Raspberry Pi circuitboard

time. 'Firstly, we had to find a solution that would fit into the current Pi form factor with minimal change, and that would also be affordable,' he explains.

'You have to pay for everything that's added somehow! Secondly, we had to connect it to the BCM2837 processor: we didn't have any "spare" USB channels so we needed to use something else.'

Having figured out a neat trick that involved swapping over the BCM2837's two Secure Digital (SD) controllers to gain access to SD input-output (SDIO) functionality, the connection was secured. 'The layout for the BCM43438 [radio chip] was a real challenge,



James Adams, Raspberry Pi hardware director

Image courtesy of www.element14.com/community

as layout really matters for radio – get it wrong and you can cause various performance degrading issues, or even issues that will cause the radio to fail to work properly and/or pass conformance at all,' Adams explains. 'Luckily, I've had a lot of experience with most other types of electronic design, and ploughed my way through plenty of reading material, as well as Broadcom's reference documents and schematics. I'm very pleased with the end result, which fits perfectly in the upper left corner of the Pi.'

With a design in hand, thoughts turned to conformance testing – a requirement in order to sell electronics to consumers in most countries. 'Conformance testing for the Pi 3 was vastly more time-consuming and expensive than with previous products. Once you have an intentional radiator [a device to produce radio waves], the required testing goes up by more than an order of magnitude,' Adams recalls. 'It boils down to the fact that you have to test each possible modulation mode and channel in all three axes. So you put the device into the test chamber, transmitting specific test data on a specific channel and using a specific modulation, and spin it around – fairly slowly – looking at the radiation with a calibrated aerial to find the highest output signal level. That's one axis done; you then do the same for the other two axes, and then repeat the process for each different modulation mode and channel.'

'You also have to meet standard EMC compliance too, making sure that your product doesn't radiate above the specified limit or fail irrecoverably when hit with various doses of radio waves in the rest of the spectrum. Finally, for Bluetooth, you also have to send the product to be officially tested with the Bluetooth SIG test schemes – one for Bluetooth Classic and one for Bluetooth Low Energy,' before you're allowed to stick the Bluetooth logo on the box! **CPC**

NEWS IN BRIEF

Researchers build 'passive' Wi-Fi

Researchers at the University of Washington have come up with a novel new wireless networking standard, which promises compatibility with existing Wi-Fi hardware at one-tenth the power draw:

Passive Wi-Fi.

Using the same energy-harvesting backscatter techniques as near-field communication (NFC) tags, the group claims its technology can transmit 802.11b Wi-Fi radio packets to an unmodified receiving device – a smartphone, during tests – at 11Mb/sec over distances of up to 100ft, yet draw 10,000 times less power than standard Wi-Fi devices. The researchers have, naturally, indicated that the technology has considerable application for low-power sensor networks, although there's no commercial release date yet.



Gareth Halfacree is the news reporter at www.bit-tech.net, and a keen computer hobbyist who likes to tinker with technology. **B** @ghalfacree

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ANTONY LEATHER'S

Customised PC

Case mods, tools, techniques, water-cooling gear and everything to do with PC modding

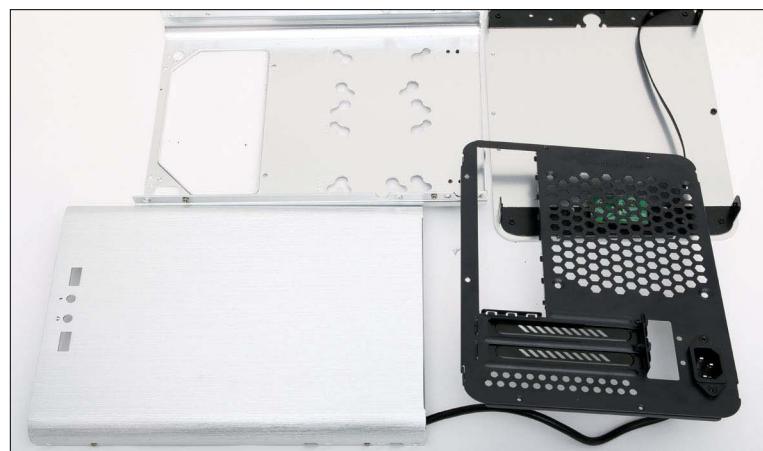
My new favourite case for modding: Raijintek's Metis

Raijintek's tiny mini-ITX case, the Metis, has been largely overlooked by the modding community. One or two projects have made use of its aluminium construction, cutting some attractive sweeping windows into the panels, and plenty of people have fitted fan grilles and AIO liquid coolers too. However, very few people have cottoned onto the fact that the case can be easily dismantled, thanks to its screw-together construction, which is devoid of pesky rivets.

This consistent use of screws opens up the case to many modifications.

The Metis can be easily dismantled, thanks to its screw-together construction, which is devoid of pesky rivets

Raijintek's tiny Metis case is very small, but it can accommodate water-cooling gear if you're prepared to fiddle with the layout



Firstly, spraying and cutting the case is much quicker and easier than with a standard case, as it's so simple to deal with the individual panels. Secondly, it's actually possible to invert the motherboard, as the motherboard tray and rear panel can simply be switched over to the other side – in a sense, the case is partly modular.

As all of the internal fixtures and fittings are screwed into place, it's a simple job to clear out the interior of any unwanted drive mounts, plus it's possible to remove the ATX PSU mount to make way for smaller SFX PSUs too. However, another feature of this case, which caught my water-cooling-obsessed eye, is that it's also possible to reconfigure the internal layout to reduce the CPU cooler height

limit, expanding the space available for water-cooling gear.

By shifting the motherboard tray forwards, you open up the space behind it for a medium-sized radiator, although doing so means you need to tweak the graphics card mount too. By using a PCI-E riser cable and making a new mount for the graphics card, I managed to flip the card over the top of the motherboard, which is rotated so that the 16x PCI-E slot is at the top, and the graphics card sits in the roof.

So what kind of water-cooling gear can you fit inside the Metis once you've made these modifications? Realistically, you'd need at least a full-height 120mm radiator to cope with a mid-range overclocked CPU and graphics card. However, there's



actually room for a full-height 140mm radiator and single fan or even a 180mm radiator too, although the latter would be limited to 35mm in depth and would probably have similar cooling capacity to a 60mm-thick 140mm radiator, and the latter would be much easier to squeeze inside the Metis.

Swapping an ATX PSU for an SFX model is a must too, as it means you get much more space inside the case, which is important for water cooling, as you'll also need to think about finding space for a pump and reservoir. As one of the most compact and reasonably priced pump and reservoir combos available at the moment, XSPC's great-looking Ion is a good choice, and it can be mounted in several locations in the Metis too. To back up my claims about the Metis being a great case for modding, take a look at this month's How to guide (see p102), as well as our cover feature (see p82).

Hands on with XSPC's Ion

Last month I discussed some images of XSPC's new Ion combined pump and reservoir unit. It isn't the most powerful option available if you use its default X20 420 pump, but two features struck me about it. Firstly, it's incredibly good-looking, and secondly, it's housed in an aluminium casing that measures only 154mm long and 58mm wide. These dimensions make it ideal for small systems, plus it's easy to maintain, with a large fill port on the top and two inlets from which to choose.

XSPC was kind enough to send me a sample, so I spent one day earlier this month testing it. It uses a Molex connector and requires a 9V startup voltage, so reducing its speed may be tricky without a fan controller, although it will only draw 6W of power, so it should work with most fan controllers if you use a Molex to 3-pin adaptor.

Powering on the pump revealed a fair bit of noise and vibration, although both were reduced by mounting the pump on foam rather than my desk. However, the noise was still similar to that of a full-



speed Laing D5 or DDC pump. Hooking it up to a fan controller worked wonders though – dropping it down to 9V reduced the noise considerably and also helped to trap air in the reservoir, which was otherwise blasted through the loop.

There are a few other small pump/reservoir combos available from the likes of Phobya, and they're a little cheaper too, but none of them looks as good as the Ion. I can thoroughly recommend the Ion if you're looking to water-cool a small system, although you'll want to pair it with a fan controller if you want your system to be quiet.

The Ion looks great, and its aluminium casing measures only 154mm long and 58mm wide

NZXT's Manta has an edgy exterior, but the internal layout isn't particularly adventurous



Are case manufacturers lazy?

Last month we looked at NZXT's Manta mini-ITX case. It's large, but also very well made and arguably worth the asking price if you're looking for a unique but edgy-looking small case. However, the internal layout offered nothing new, which caused quite a stir in some forums – some people were expecting new ideas from NZXT, and some folks were calling manufacturers with similar designs lazy. After all, the company hasn't shied away from thinking outside the box in the past. In addition, Corsair has asked members of bit-tech's forums what they thought was lacking from current mini-ITX cases, given some of the scathing comments in the Manta's review thread.

I'm a big fan of the mini-ITX form factor, and I've noticed that both NZXT and Corsair's mini-ITX case designs have been limited by the companies' tendency to focus on support for their own all-in-one liquid coolers. As a result, the Manta needed to house NZXT's large 140mm Kraken radiators, while the need to accommodate Corsair's often smaller Hydro Series coolers meant that its Obsidian 250D and Graphite 380T cases weren't particularly water-cooling-friendly.

Water-cooling isn't the be all and end all with a small case, of course, but if you look at many of the tower-type mini-ITX cases, such as the Phanteks Evolv ITX, Fractal Define Nano S and the Manta, they all have a similar layout and features: they use ATX PSUs, support large graphics cards and big radiators, but all use a fairly standard layout, with the motherboard, graphics card and PSU all mounted in the same places used in smaller cases.

The trouble is that there's a mass of wasted space, whether you're cooling your PC with air or water. Yes, these cases are great for water-cooled systems, but they could still accommodate water-cooling gear and be much smaller too.

It will be interesting to see what Corsair has to say on the matter as well, given that it now has its own SFX PSU and hasn't released a new mini-ITX case for a while. **CPC**

How to Move GPU and motherboard mounts

Squeeze loads of water-cooling gear into a tiny case by reorientating your kit. Antony Leather gets the Dremel out

 **TOTAL PROJECT TIME** / 24 HOURS

Last month we looked at creating an external water-cooling system to keep your case's footprint to a minimum while still using high-end components and full custom water cooling. However, there's one way to squeeze a modest water-cooling system into a small case such as the Raijintek Metis.

Basically, if you want to water-cool your mini PC, you don't need loads of space for a CPU cooler. In fact, with right-angled fittings, you only need around 60mm (or less) of clearance. As a result, the motherboard tray can be moved much closer to the side panel, making room for water-cooling gear or other hardware behind the motherboard or even the PSU. You'll also need to move the graphics card mount and use either PCI-E riser cards or riser cables, and reconfigure the rear panel of your case, but the end result is a tiny case with good water-cooling support and easy maintenance.

TOOLS YOU'LL NEED



Mini-ITX case (Raijintek Metis) / www.overclockers.co.uk



Drill and drill bit / Most hardware stores



Matt black spray paint / Most hardware stores



Metal epoxy / Most hardware stores



Dremel and cutting discs / Most hardware stores



PCI-E riser cards or cables / www.amazon.co.uk



Metal files and sandpaper / Most hardware stores



P38 filler and masking tape / Most hardware stores



1.5mm sheet aluminium / www.ebay.co.uk



1 / CHECK HARDWARE WILL FIT

You need to make sure not only that all your hardware and cooling gear will fit, but also that it will be easily accessible, and provide enough space to route your tubing. As you'll be moving the graphics card, make sure there will be enough clearance in its new position.



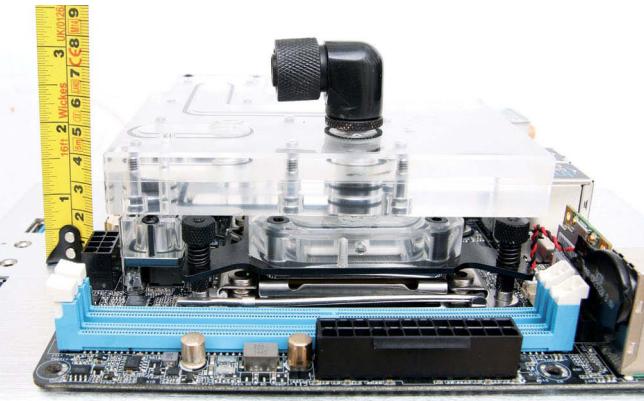
2 / REMOVE DRIVE CAGES OR MOUNTS

If you want to maximise the amount of water-cooling space, you'll need to get rid of as many internal fixtures as possible. With the Raijintek Metis we're using, we also want to remove the ATX PSU mount, so we can switch to an SFX PSU to save more space.



3 / TEST-FIT MOTHERBOARD

To get an idea of where the motherboard needs to be installed, place it in the case, complete with your waterblock and fittings. See how close you can get it to the side panel once it's installed, while checking that the side panel can still slide freely into place.



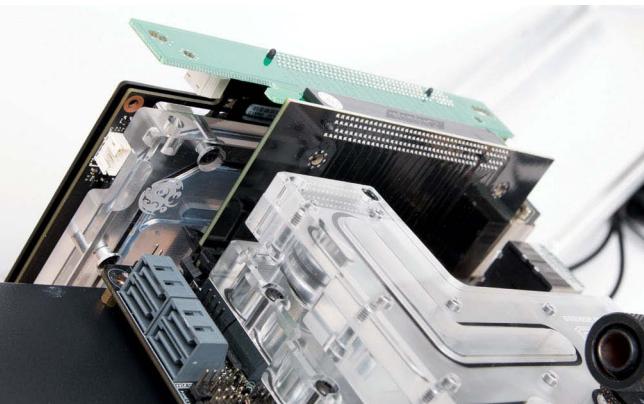
4 / CONFIRM WATERBLOCK CLEARANCE

The clearance you need is important, as it dictates the distance the motherboard can be positioned from the side panel, where the motherboard tray can be mounted and how much room you'll have for other hardware behind it. Allow for a few millimetres of extra leeway.



6 / TEST-FIT PUMP AND PSU

Once you know where the motherboard will be situated, test-fit the pump and PSU. Ideally, you want to mount the pump using anti-vibration foam, rather than screwing it directly to the chassis. Make sure that neither part will foul the graphics card in its new position.



8 / FIT PCI-E RISER CARD

PCI-E riser cards offer an easy way to point a graphics card back into the case while still connecting it to the PCI-E slot. However, the card will be facing downwards, which may not be the best location in your case. If you want more flexibility, consider a riser cable (see step 9).



5 / REMOVE MOTHERBOARD TRAY

In our case, the motherboard tray is screwed into place, so it's quite easy to remove. However, you may need to drill out some rivets, depending on the case you're using. Don't worry about the size of the tray – you can always trim it to size later.



7 / DISMANTLE CASE

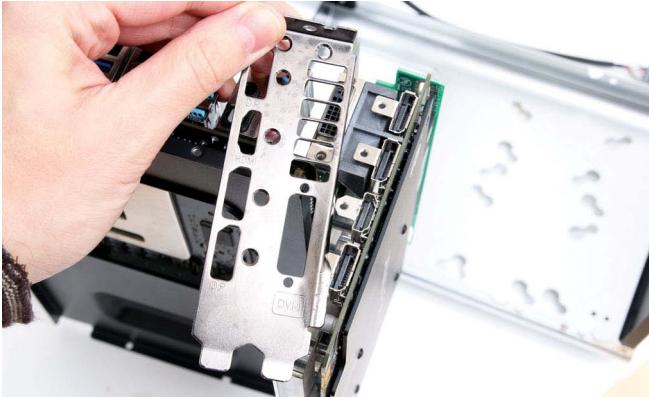
To modify the case, it's necessary to remove the rear panel entirely. Again, the Metis comes apart easily with screws, but you may have to drill out some rivets on other cases. Be sure to keep all the screws and fittings safe so that you can reassemble it.



9 / CONSIDER RISER CABLE

A flexible PCI-E riser cable will enable you to position the graphics card facing up or down, and at any distance from the PCI-E slot. However, you may need to create a support if you're using a large graphics card. You'll need an insulated riser cable, as pictured.



**10 / REMOVE GRAPHICS CARD BRACKET**

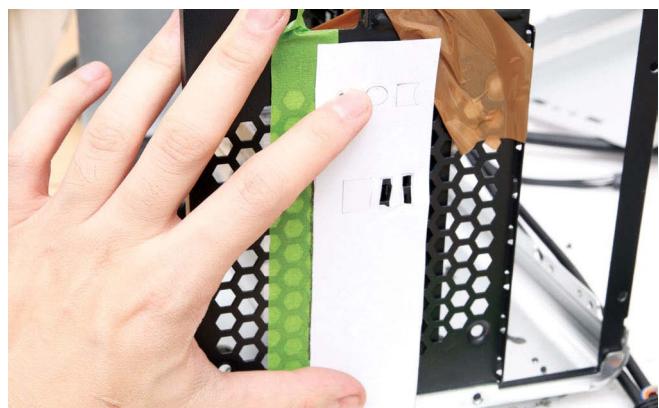
To test-fit the graphics card, remove the rear bracket so that you can offer it up to the rear panel. It's usually just held in place with screws. Once it's removed, lay it flat against the rear panel to find the best location for the expansion slot.

**11 / TEST-FIT HARDWARE**

Connect the motherboard to the graphics card, using either riser cards or a cable, and offer it up to the rear panel. You may want to mount the graphics card so that it's in the centre of the case if it's viewable through a top window.

**12 / MEASURE I/O PANEL FOR TEMPLATE**

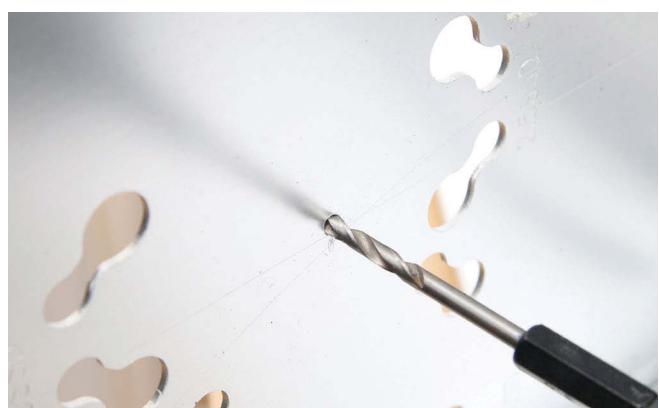
The easiest way to cut out the precise hole for the I/O shield is to create a template. You need to cut out a section that measures 45mm x 158mm.

**13 / APPLY MASKING TAPE**

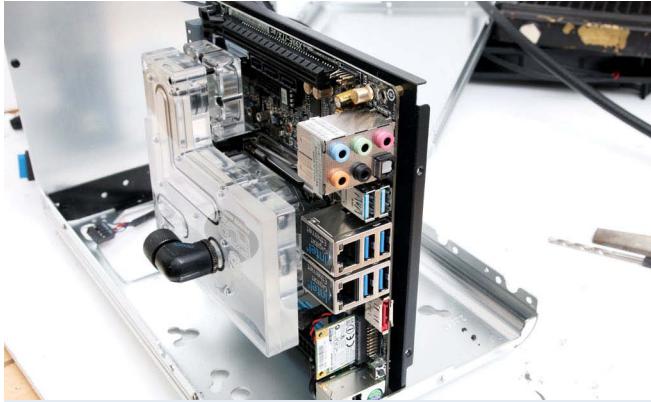
Place masking tape over the area to be cut out. This process will enable you to use a pen to mark up the area with a guide for your Dremel, and also prevent you from scratching the case if you slip.

**14 / MODIFY MOTHERBOARD TRAY**

We have no need for the extra length on our motherboard tray – in fact, it's where we intend to place our pump and PSU. Cut away any excess you don't need using a Dremel and cutting disc.

**15 / DRILL TRAY MOUNTING HOLES**

The motherboard tray needs to be secured from at least two sides. To start, we drilled holes in the base to secure it from below. We used a 3mm drill bit, so we can use standard 6-32 PC screws to tap into the metal and secure the tray. You can raise the tray with plastic washers.



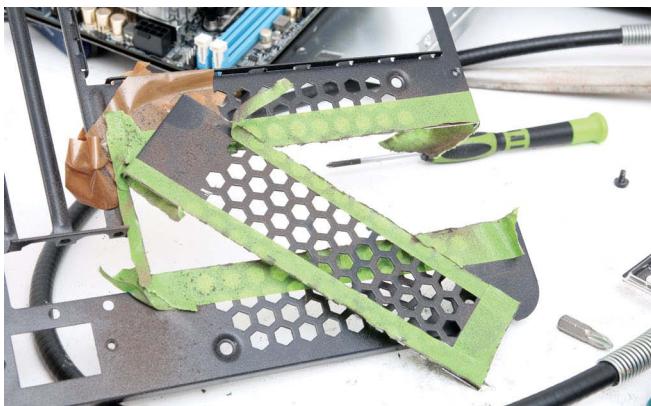
16 / SECURE MOTHERBOARD TRAY

We found that using 2mm washers allowed the motherboard to sit away from the case's base, and they also made the rear I/O panel easier to fit at the rear. You could also use nuts and long 6-32 screws to raise the motherboard even further.



17 / CUT OUT SPACE FOR I/O PANEL

Even with the motherboard raised a few millimetres, we still needed to trim the rear of the bottom panel to allow the rear I/O shield to slot into place. You can use a Dremel and cutting disc to cut away sections here.



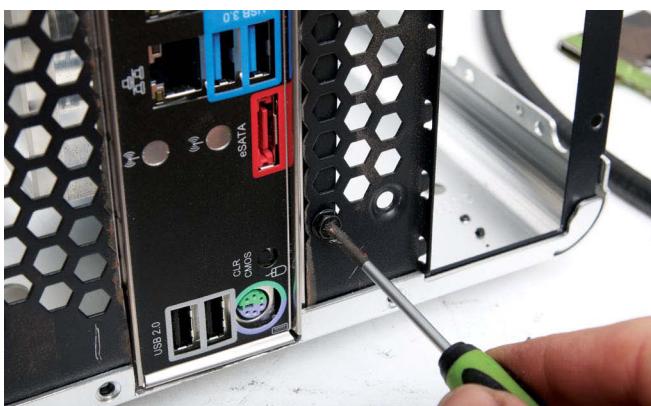
18 / CUT OUT I/O PANEL SECTION

Using your template, cut away the I/O shield section with a Dremel and cutting disc. Most cases use steel in this area, so you may need to use a heavy-duty cutting disc. When you've finished cutting, smooth the edges with a metal file.



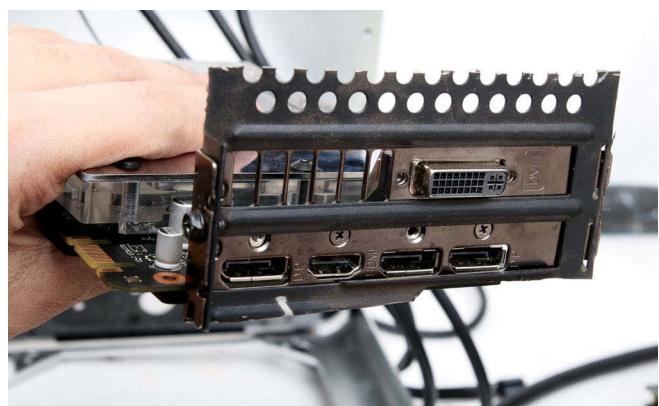
19 / TEST-FIT I/O SHIELD

Hopefully, your I/O shield will now happily slot into place. If necessary, though, you can enlarge the hole further with a metal file until you get a snug fit.



20 / SCREW MOTHERBOARD TRAY TO REAR

You can now secure the motherboard tray to the rear of the case. We had some handy vents in this location, so we didn't have to drill any holes – using vents for screwholes is fine as long as the screws are secure.



21 / CUT OUT EXPANSION SLOTS

Cut out the panel with the PCI-E slot's backplate holes from the case, and the part of the case where you'll be transplanting it. Use a Dremel and cutting disc, and cut as close to the backplate holes as possible, leaving enough overlap to glue the panel into its new location.



**22 / APPLY METAL EPOXY**

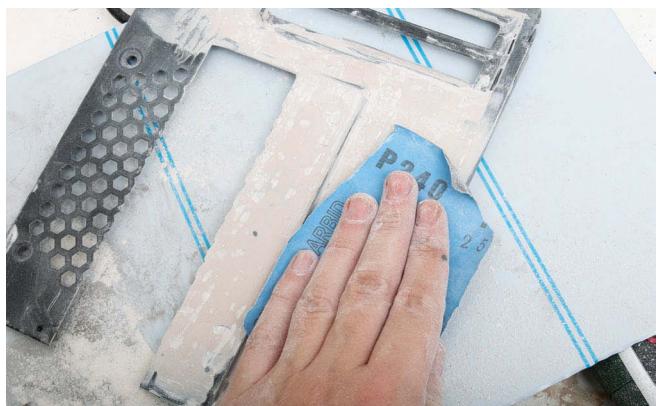
Mix up some metal epoxy and place a small amount of it around the edge of the expansion slot panel. Position the expansion slot panel in its new location, ensuring there's good contact, then leave it to one side to dry.

**23 / CUT OUT ALUMINIUM SUPPORT BRACE**

As we've chopped the rear panel to pieces, it needs a support brace to provide rigidity. Measure up the size of the panel needed, covering as much of the panel as possible, then cut it out from 1.5mm sheet aluminium with a Dremel and cutting disc, before filing it smooth.

**24 / APPLY METAL EPOXY TO BRACE**

Mix up a fair amount of metal epoxy and fix the aluminium sheet in place, removing any protective film on that side beforehand. Place a heavy item on top of it for ten minutes while the glue sets, mopping up any excess epoxy underneath.

**25 / APPLY FILLER AND SAND IT**

Use P38 filler to cover any areas with holes or overlapping panels, covering up any unsightly joins or cuts, then use 240-grit sandpaper to smooth over the filler. Don't be afraid to apply more filler if you find any holes in the original application.

**26 / SPRAY PANEL**

Wash the panel to remove any dirt and filler dust, and allow it to dry. Then use matt black spray paint to cover the entire panel. This coat of paint enables you to hide the parts you've glued or added to the panel, so it looks like it came out of the factory in this configuration.

**27 / REASSEMBLE CASE**

Once the paint is dry, reassemble the case and install your water-cooling gear. The rest of the build process will depend on the case you use, but you can see the further steps we took to modify the Raijintek Metis for water cooling in our cover feature on p82. **CPC**

WIN! A Roccat Ryos MK FX gaming keyboard and Nyth mouse



PLUS!
TWO
ROCCAT
MICE

Our kind pals at acclaimed peripheral maker Roccat have left us with a top-notch Ryos MK FX mechanical keyboard, complete with RGB lighting and Cherry MX Brown switches, to offer up to a lucky winner of this competition, along with a Roccat Nyth – the company's amazingly flexible modular MMO gaming mouse.

Not only that, but there are also two mice going for runners-up prizes – a Roccat Kiro and a Roccat Kova, the latter of which is our current Elite-listed ambidextrous mouse.

Purpose-built for hardcore gamers, the Ryos MK FX is one of the most advanced mechanical gaming keyboards on the market. Using all of Roccat's industry expertise and gaming experience, the Ryos MK FX boasts a feature set so comprehensive and a design so eye-watering you'll be leading the pack by miles – complete with 16.8 million colour per-key RGB illumination.

Meanwhile, the Roccat Nyth meets the demands of MMO play with deep button modularity that fluidly transitions into a MOBA or FPS master tool with ease.

No matter the genre or taste, its catalogue of side parts and buttons joined with an expertly engineered foundation combine to make a revolutionary device that serves the imagination, creativity and high standards of gamers today.

■ First prize

Roccat Ryos MK FX mechanical gaming keyboard



FIRST
PRIZE

■ Second prize

Roccat Kova gaming mouse



SECOND
PRIZE

■ Third prize

Roccat Kiro gaming mouse



THIRD
PRIZE

To be in with a chance of winning one of these prizes, simply answer the question below:

QUESTION: What's the name of Roccat's software system?

A. Zerg **B. Swarm** **C. Mob**

Email your answer to competition@custompcmag.org.uk, with 'Roccat Competition 153' in the Subject line.

Closing date 26 May, 2015. See www.dennis.co.uk/comp/terms for the full competition rules.

Readers' Drives

InWin909 MbK

Richard Keirsgieter's wife wanted a living room PC, and the result is this gorgeous blue and black In Win 909 mod, with a custom reservoir and rigid PEGT tubing

CPC: What inspired you to use the In Win 909 for this project?

Richard: There's a little story here. In Win contacted me about making an In Win 805 build for a small event. I told In Win that I wanted to do it, but that I wanted another nice case for my next new project. The In

Win 909 was pretty new and In Win offered to send me one when it became available. Once I received the 909, my wife saw it and she really liked the looks and tempered glass, so I asked her to choose the theme and colours for this project. Her favourite colours are black and blue, and she really likes the squares on the back.

My wife also finally told me that she wanted a PC in the living room and, despite many years of modding, I've never had a PC in my living room before – my wife didn't want one beforehand, because all the other rooms in the house had PCs in them, and the living room was

her place. This PC is hers, and it was a pretty hard assignment to make it just the way she wanted. My mission is completed, though, because this PC is now running in the living room.

CPC: What does the name mean?

Richard: I always use the original case's brand and model number in my mod names, and then I usually add the letters 'MbK' (made by Kier) – the end result is good for my own business and that of the case manufacturer. As a result, this mod is called 'InWin909 MbK.' It might not be original but it does the trick!

CPC: What specs did you choose?

Richard: I still had a beautiful Gigabyte GA-X99-Gaming 5P motherboard with an Intel Core i7-5960X in my hardware collection, which I partly decided to use because the CPU socket has RAM slots on either side of it, which provides a great symmetric look. I also had a 32GB Corsair Dominator memory kit (4x8GB), so I bought one more kit to make up a total of 64GB, along with a few blue light bar kits to match the build.

For the GPUs, I used a couple of Asus Strix GTX980-DC2OC-4GD5 cards and installed EKWB EK-FC980 GTX Strix waterblocks on them. I then used an EK-Supremacy Evo waterblock to cool the CPU and two EK-CoolStream PE radiators for the two water-cooling loops. One loop uses the 240mm version to cool the CPU, while the other loop is connected to the 360mm version to cool the graphics cards. To get the coolant flowing, I used beautiful EK-XTOP Revo D5 PWM pumps, which I think are real eye-catchers.

CPC: What other mods have you built?

Richard: I've lost count now, but I

think I've now made over 40 case mods and scratch builds, some of which were for family and friends, but most of them were built for companies and their events. The latter is what I really like doing – making showcases with which you can show people what's possible with certain cases, hardware and water-cooling gear.

CPC: What difficulties did you come across?

Richard: Case modding isn't rocket science; it's all about good measuring, your choice of hardware and cooling gear, and thinking twice before acting. I didn't have many issues when I was building this project because I already had so much experience from the other mods I've made. You basically have to look at the possibilities of the object you want to mod – it's best to sit in front of the case and do some good brainstorming. Also, remember that every modification you make is a project on its own. My only first with this mod was making the custom reservoir, which was my first experience of tapping holes for fittings and adaptors in acrylic, and it all had to be perfect because the reservoir sits above my precious hardware.

CPC: Why did you use rigid tubing and did this decision present any issues?

Richard: I always use rigid tubing in my builds because of the clean look, and the ability to make straight horizontal and vertical lines. However, InWin909 MbK was my first build with PETG tubing and I love it!

This material is so easy to cut and it's much stronger than acrylic. InWin909 MbK was also my first build to use bended tubing. I normally use a lot of fittings and



/MEET THY MAKER

Name Richard Keirsgieter (aka Keir)

Age Almost 40

Location Ijmuiden, Netherlands

Occupation Technical building management

Main uses for PC Games, photos and build logs

Likes Family, friends, good food, watching movies, new hardware, visiting events, good relationships with sponsors and Facebook

Dislikes Trolls and people who are full of it. We all had to start somewhere. When a new modder has questions we should help each other!

SEE THE FULL
PROJECT LOG:
[http://tinyurl.com/
lnWin909MbK](http://tinyurl.com/lnWin909MbK)



SYSTEM SPECS

CPU Intel Core i7-5960X

Graphics card 2x Asus Strix GTX980-DC2OC-4GD5

Case In Win 909

Memory 64GB (4x 8GB) Corsair Dominator with blue light bars

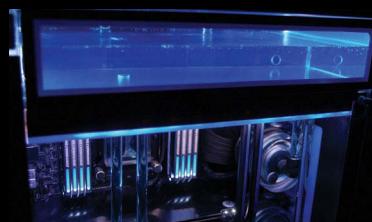
Motherboard Gigabyte GA-X99-Gaming 5P

Storage 3x 128GB Corsair Force LX SSDs

PSU Cooler Master V1200

Cooling Custom water-cooling loop, featuring EK-Supremacy Evo CPU waterblock, 2x EK-FC980 GTX Strix GPU waterblocks, EK-XTOP Revo D5 PWM pump, custom reservoir, EK-CoolStream PE 240 and PE 360 radiators, EK fittings and adaptors, PEGT tubing





adaptors to achieve straight lines and turn corners in a water-cooling loop, but I wanted to do this build differently, so I bent most of the tubing after it goes up from the waterblocks.

Bending tubes takes practice but it's great once you get the hang of it, and it saves using lots of fittings and adaptors. I also used the tubing to route power to the graphics cards. I used the original flat cables

from the V1200 PSU, removed the connectors and pushed them through the rigid tubing. I then put the connectors back on the cables and coloured these tubes black with a blue stripe in the centre.

than one build at a time, and this build didn't have a deadline, so I built it in approximately three months (evenings and weekends). Waiting for the products I needed also took up a large part of this time.

CPC: What tools and machinery did you use?

Richard: I mainly work with hand tools, such as my Dremel, drill, jigsaw, fretsaw, file and small tools. This approach may be old-school, but I really like to feel the materials with which I'm working and the process is much faster for me than drawing and CNC milling. However, I have a great buddy with his own homemade CNC mill, which I use to make any parts that are too difficult to make by hand. I also used a professional company to make the custom reservoir, as it sits above the hardware and I had to be sure there were no leaks.

CPC: What did you learn from the build process?

Richard: I learn more from every case mod or scratch build I make. With this one in particular, I learned how to bend tubes, work with PETG tubing and tap (straight) holes for fittings and adaptors in acrylic. I really like the use of custom reservoirs in builds, so I'll be making more of them.

CPC: Are you happy with the end result, and is there anything you'd do differently if you built it again?

Richard: Yes, I'm very happy, because my wife is happy and I've now got myself a PC in the living room. There's actually nothing I would do different in this build – if I don't like something I've made then I usually just fix it anyway. **CPC**

BE A WINNER

To enter your machine for possible inclusion in Readers' Drives, your mod needs to be fully working and, ideally, finished based in the UK. Simply log on to www.bit-tech.net and head over to the forums. Once you're there, post a write-up of your mod, along with some pics, in the Project Logs forum. Make sure you read the relevant rules and advice sticky threads before you post. The best entrant each month will be featured here, where we'll print your photos of your project and also interview you about the build process. Fame isn't the only prize; you'll also get your hands on a fabulous selection of prizes – see the opposite page for details.

CPC: How long did the build process take?

Richard: I normally work on more

Win all these prizes!

We've teamed up with some of the world's leading PC manufacturers and retailers to offer this great range of prizes to each lucky Readers' Drives winner. If your creation is featured in the magazine then you'll walk away with all of the prizes listed on this page, so get in your entries!

Corsair graphite Series 230T case and RM 550w Modular power supply

TOTAL VALUE £150 inc VAT / MANUFACTURER www.corsair.com

Corsair believes that a great PC starts with a great case. The Corsair Graphite Series 230T is a compact expression of this core philosophy. With stylish looks and a choice of three different colours, it packs in a remarkable number of features to provide builders with tonnes of room for expansion and amazing cooling potential. Like all Corsair cases, it's built using the finest materials and finished to the highest standards, so it will withstand several years of upgrades. Plus, to make sure it stands out from the crowd, the 230T features Corsair's new Air Series LED high-airflow fans, providing distinctive lighting with low-noise, high-airflow cooling.

Just as a quality case is essential to building a quality PC, a high-performance, a high-quality power supply is also a vital ingredient. The all-new RM series has been built from the ground-up to deliver unmatched reliability alongside 80Plus Gold efficiency, and all with the absolute minimum of noise. It uses specially optimised quality parts to reduce sound at the component level, and it's completely silent below 40 per cent load, thanks to its Zero RPM fan mode. It's also fully modular, allowing for the maximum amount of flexibility during installation. With a Corsair Graphite 230T case and an RM 550W Modular power supply at the heart of your build, you'll have the foundations for a truly awesome gaming machine.



Mayhems coolant and dyes

VALUE £50 inc VAT / MANUFACTURER www.mayhems.co.uk

Cooling performance is only one part of the equation when it comes to kitting out your rig with custom water-cooling gear. The other major bonus is that all those tubes and gleaming fittings just make your PC look damn sexy, and they look even better when they're pumped full of fancy coloured coolant. As such, we're particularly pleased to have the folks at Mayhems now on board with Readers' Drives; they're currently offering two 1-litre bottles of Mayhems' Pastel Ice White coolant, along with a selection of five dyes, so you can choose the colour that best complements your PC. Check out the blue coolant in our own mini PC mod on the cover of Issue 109 for an example of what's possible with some Mayhems coloured coolant.

Phobya Modding Kit

VALUE £50 inc VAT MANUFACTURER www.phobya.com, www.aqua-tuning.co.uk

The Phobya modding kit is designed with the modder in mind, offering great value for money and quality products. The kit includes Nano-G 12 Silent Waterproof 1,500rpm multi-option fans, which use an innovative fan-blade design. As standard, the fans include braided black cables to keep your case looking as neat as possible. The fans are also supplied with a special cable that lets you run the fan at 5V rather than 12V, reducing the noise emitted in order to help you to build a silent system.

The kit also includes the 60cm Phobya 3-pin Molex to 4x 3-pin Molex Y-cable. This pre-



braided extension cable gives you extra routing options in your case, and it also enables you to run up to four fans from one compatible motherboard header. Meanwhile, the Phobya SATA 3 cables included in the kit offer the same great quality braiding as the rest of the Phobya range, while also securing your connection with latched connectors.

As well as this, the kit includes the Phobya SlimGuide Controller, which gives you the option to vary the speed of other fans in your case, while the Phobya TwinLEDs let you shine a light on your mods.

CUSTOM PC

REALBENCH 2015

in association with 

Give your PC a workout with our new benchmark suite, and see how your rig compares to other readers' machines

Gimp

We use Gimp to open and edit large images. Unlike our previous Gimp test, this one uses more than one CPU core, although it's still more sensitive to clock speed increases than more CPU cores.

Handbrake H.264 video encoding

Our heavily multi-threaded Handbrake video encoding takes full advantage of

SHOUT OUTS!

We had an interesting addition to the top ten this month – a mysterious user with no username hit number nine with a 4.4GHz Core i7-5960X, getting a score of 198,971. If that's you, we'd love to hear more! Congratulations also go to new entry, mauserk98 at number 15, overclocking a Core i7-5930K to 4.63GHz.

many CPU cores, pushing them to 100 per cent load.

LuxMark OpenCL

This GPU compute test is the only synthetic part of our suite, although the renderer is based on the real LuxRender physically based rendering software. As 3D rendering is a specific workload that not everyone will use, and because OpenCL support isn't standard in most software, this section is given just a quarter of the weighting of the other tests in the final score.

Heavy multi-tasking

Our new multi-tasking test plays a full-screen 1080p video, while running a Handbrake H.264 video encode.

Scores

RealBench 2015 breaks down the scores for each test, then gives you a total system score and a percentage reference score.

BENCHMARK YOUR PC

Download the benchmarks from www.asus.com/campaign/Realbench and, before you run them, disable any power-saving technologies in your BIOS that change your CPU clock speed, or the leaderboard won't record your overclock frequency properly. To post a score on the leaderboard, go to Save Upload File in the RealBench 2015 app's Results menu, and save your results in an RBR file. You need to select Offline Uploads on the leaderboard site, sign up for an Asus account and upload your file.

On an Intel system, the 100 per cent reference score comes from a stock-speed Core i7-4790K, with 16GB of Corsair 2,400MHz DDR3 memory, a 240GB OCZ 150 SSD, an Asus Maximus Gene VII motherboard and an Nvidia GeForce GTX 780 3GB graphics card.

On an AMD system, the 100 per cent reference score comes from a stock-speed A10-7850K APU, with 8GB of Corsair 2,133MHz DDR3 memory, a 256GB Plextor M5 Pro SSD and an Asus A88X-Pro motherboard, using the APU's integrated graphics. **CPC**

CHROME WARNING

At the moment, Google's Chrome browser flags up the RealBench 2015 download as potentially harmful, and we're aware of this issue. The file is perfectly safe, however – please ignore this warning.

CUSTOM PC REALBENCH 2015 LEADERBOARD

RANK	SYSTEM SCORE	REFERENCE	USERNAME	MOTHERBOARD	CPU	CPU CLOCK	MEMORY	PRIMARY GPU
1	275,683	240.9%	8pack	Asus Rampage V Extreme	Intel Core i7-5960X	5.5GHz	16GB Kingston 3000MHz	Nvidia GeForce GTX Titan X
2	233,375	203.9%	ian.parry3	Asus Rampage V Extreme	Intel Core i7-5960X	4.6GHz	32GB G.Skill 3200MHz	Nvidia GeForce GTX Titan X
3	221,477	193.5%	Chris_Waddle	Asus Rampage V Extreme	Intel Core i7-5960X	Not reported	16GB Corsair 2666MHz	Nvidia GeForce GTX Titan X
4	219,415	191.7%	Luke@DinoPC	Asus Rampage V Extreme	Intel Core i7-5960X	4.6GHz	16GB Corsair 3276MHz	Nvidia GeForce GTX Titan X
5	215,694	188.5%	duba1	Asus X99-Pro/USB 3.1	Intel Core i7-5960X	4.7GHz	32GB Corsair 2800MHz	Nvidia GeForce GTX 980 Ti
6	211,331	184.6%	Menthal	Asus Rampage V Extreme	Intel Core i7-5960X	Not reported	32GB G.Skill 3200MHz	Nvidia GeForce GTX 980 Ti
7	206,723	180.6%	stuart	Asus Rampage V Extreme	Intel Core i7-5960X	4.41GHz	16GB Corsair 3000MHz	Nvidia GeForce GTX 780 Ti
8	201,446	176.0%	CustomPC	Asus Rampage V Extreme	Intel Core i7-5960X	4.3GHz	16GB Corsair 2666MHz	Nvidia GeForce GTX Titan X
9	198,971	173.9%	?	Asus Rampage V Extreme	Intel Core i7-5960X	4.4GHz	64GB Corsair 2400MHz	Nvidia GeForce GTX 980 Ti
10	197,964	173%	Carbonleg	Asus X99-E WS	Intel Core i7-5960X	Not reported	32GB Corsair 2400MHz	AMD Radeon R9 200 Series
11	189,230	165.3%	shadowsrayne	Asus Rampage V Extreme	Intel Core i7-5960X	4.2GHz	32GB Corsair 2133MHz	Nvidia GeForce GTX 980
12	185,219	161.8%	dax	Asus Rampage V Extreme	Intel Core i7-5960X	3.97GHz	32GB Corsair 2448MHz	Nvidia GeForce GTX 980
13	181,058	158.2%	richcardnpaul	ASRock EP2C602	Intel Xeon E5 2670	3.3GHz	32GB Kingston 1866MHz	AMD Radeon R9 200 Series
14	179,386	156.7%	mboglie	Asus Rampage V Extreme	Intel Core i7-5960X	4.2GHz	32GB Crucial 2133MHz	Nvidia GeForce GTX 980
15	177,350	155.0%	mauserk98	Asus Rampage V Extreme	Intel Core i7-5930K	4.63GHz	16GB Team Group 3000MHz	AMD Radeon R9 200 Series
16	175,745	153.6%	dis80786	Asus Rampage V Extreme	Intel Core i7-5930K	4.4GHz	16GB Corsair 2666MHz	Nvidia GeForce GTX 970
17	173,154	151.3%	mark.gee93	Asus Rampage V Extreme	Intel Core i7-5930K	4.49GHz	12GB Corsair 3168MHz	Nvidia GeForce GTX 980 Ti
18	172,828	151%	mdottwo	Asus Rampage V Extreme	Intel Core i7-5820K	4.4GHz	16GB G.Skill 2766MHz	AMD Radeon R9 200 Series
19	167,332	146.2%	grozzle	ASRock X99M Killer	Intel Core i7-5930K	4.48GHz	32GB Kingston 3071MHz	AMD Radeon R9 200 Series
20	167,002	145.9%	maliepaard.chris	MSI X99S SLI Plus	Intel Core i7-5820K	4.49GHz	16GB Corsair 3000MHz	Nvidia GeForce GTX 980 Ti

Folding@Home

Join our folding team and help medical research

MILESTONES THIS MONTH

USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE
MH3	20000	Mr_Blue_Jam	400000	Stormcrow	3000000	Jon_Simmo	10000000
Nitro3d	20000	Reaperman	400000	TrekkieStu	3000000	matgsi	10000000
ewink20	30000	The_Notorious_Pizza_Boy_(Mike)	400000	Woodgnome200	3000000	SP1	20000000
Goldmaster	30000	LEACHIE007	500000	Just_G	4000000	Dave_Laffin	30000000
Glynn_Mason	40000	Ayeska	600000	slayer200230	4000000	debs3759	30000000
AMDrftw!	50000	CTHW	600000	smiler	4000000	Oatylapjack	30000000
trma97	60000	john251282	600000	Acanuck	5000000	Unicorn	30000000
HiroMilo	80000	FREE_WORLD	700000	Bobthetoolnut	5000000	peete	40000000
Petersheed	80000	PeteUKLancs	800000	ghodula	5000000	Qazax	40000000
BP_Evil_Element	90000	Craig_Morris	1000000	Shirty	5000000	SirBenjaminNunn	40000000
Capt-Camm-Nett	90000	Master_Luke	1000000	Bluce_Ree	6000000	slowpurple	60000000
thecrazyeyes	90000	NoizDaemon666	1000000	Ganey	6000000	Angy	70000000
whiskeyecho	90000	stevec83	1000000	PURE	6000000	8Core	90000000
bradbooth	100000	CADmunkey	2000000	QuasarGreg	6000000	Andy_J	90000000
Pickles96	100000	carbontwelv	2000000	valkynaz	6000000	Cmaxx	90000000
Tango_Echo_Alpha	100000	conficent	2000000	scoobyzilla	7000000	madmatt1980	90000000
Fersigo	200000	GreenPig	2000000	bigrew	9000000	daxchaos	100000000
Dustspeck101	300000	MikePreston	2000000	kcanti	9000000	PcShedTV	100000000
pig_farmer_uk	300000	shukanryukid	2000000	kornvdd	9000000	Desertbaker	300000000
Bocs_o_lyffantod	400000	wew	2000000	anfortis	10000000	Lordsoth	500000000
crazeey	400000	FurstyFerret	3000000	davmonk	10000000	Scorpuk	800000000
For_Those_We_lost	400000			GreenDemon360	10000000		

WHAT IS FOLDING?

Folding@home uses the spare processing cycles from your PC's CPU and graphics cards for medical research. You can download the client from <http://folding.stanford.edu> and our team's ID is 35947. Once you pass a significant milestone, you'll get your name in the mag. You can also discuss folding with us and other readers online at the www.bit-tech.net forums.



TOP 20 OVERALL

RANK	USERNAME	POINTS	WORK UNITS
1	Nelio	2,559,182,411	178,135
2	DocJonz	1,933,651,005	188,718
3	HHComputers	1,242,737,353	43,198
4	coolamasta	889,891,225	182,753
5	piers_newbold	844,664,802	52,041
6	Scorpuk	814,925,957	33,073
7	PC_Rich	598,047,952	84,624
8	StreetSam	571,113,589	90,231
9	Lordsoth	518,078,829	101,145
10	johnim	494,892,154	82,529
11	Dave_Goodchild	465,923,185	119,946
12	Slavcho	459,632,044	37,778
13	Laguna2012	386,290,890	26,362
14	The_M2B	384,577,661	62,733
15	Desertbaker	302,641,109	21,839
16	KevinWright	260,521,762	32,288
17	phoenicis	250,044,587	95,660
18	Dickie	244,249,726	14,948
19	TheFlipside	236,007,304	24,186
20	apeman556	234,013,339	30,788

TOP 20 PRODUCERS

RANK	USERNAME	DAILY POINTS AVERAGE	OVERALL SCORE
1	HHComputers	6,512,290	1,241,862,949
2	DocJonz	4,009,073	1,933,033,631
3	PcShedTV	3,719,326	125,294,911
4	Lordsoth	1,588,707	518,018,764
5	piers_newbold	1,337,318	844,499,631
6	Scorpuk	1,272,710	814,795,874
7	Nelio	1,206,856	2,558,986,036
8	daxchaos	1,141,047	105,773,227
9	apeman556	977,721	233,855,106
10	coolamasta	943,823	889,811,286
11	Slavcho	897,535	459,497,661
12	PC_Rich	728,282	597,926,992
13	Dickie	720,570	244,105,411
14	madmatt1980	623,636	91,297,062
15	Tattyasnuc	556,119	89,748,047
16	Desertbaker	538,203	302,594,039
17	Roveel	516,269	187,885,187
18	BeezaBob	507,604	129,360,722
19	Laguna2012	506,402	386,234,613
20	KevinWright	491,141	260,396,119



JAMES GORBOLD / HARDWARE ACCELERATED

CAN WE MOVE ON FROM THE 1950s?

And finally remove the hard disks from our PCs? Asks James Gorbolt

I've always hated extraneous mechanical and electrical noise, be it the whirl of noisy fans, the whine of a washing machine or the irregular rumble of a fridge compressor. Fortunately, there are now many ways to make your PC quieter – from your choice of cooling system to using low-power components that don't emit much waste heat. However, there's one component in many PCs that still makes a hell of a racket – the hard disk.

With the platters typically spinning at 7,200rpm, a hard disk makes a very irritating, high-frequency whine, plus a noise akin to someone shaking a half-empty biscuit tin when the heads are moving about, seeking data. As an added insult, hard disks are painfully slow as primary storage devices, with even the fastest drives struggling to hit 200MB/sec. In comparison, even the cheapest budget SSD from an obscure brand can transfer data quicker, let alone a glorious PCI-E 3 NVMe drive from Intel or Samsung, which can silently transfer data more than ten times faster than a hard disk.

That said, the hard disk still has a role to play in bulk storage, providing far more capacity per pound than an SSD, so it remains the sensible choice for archiving music, photos and videos. That's why I removed the hard disks from my PCs several years ago, and relocated them to a couple of NAS boxes. Plus, thanks to the wonders of HomePlug adaptors, these NAS boxes are tucked away in places even my sensitive ears can never hear them, such as the loft and garage. Admittedly, the data transfer rate between the disks in the NAS boxes and my PCs are now measured in double-digit MB/sec rather than

**Hard disks make a noise
akin to someone shaking a
half-empty biscuit tin when
the heads are moving**

hundreds, but unless you're working with those files and editing them, it doesn't matter how fast you can access them.

The days of having to choose a hard disk over an SSD for budgetary reasons are coming to an end too, with 120GB SSDs available for just £30 and gaming PCs with SSDs starting from just over £600.

I must confess that I used to have a soft spot for the 1950s technology that drives the hard disk. I fondly remember getting my first hard disk, a full-height 5.25in drive with a 20MB capacity that needed its own 8-bit ISA interface card, as IDE had yet to be invented.

Although it too made a huge amount of noise, it was a hell of a lot quieter than old floppy disk drives, and the performance at the time was startling. For months it was also the talk of the school playground, as I was the only child in school to have a computer that 'remembered' the OS and games on it, and didn't need them to load one by one from disks or tapes every time you turned it on.

However, enough is enough and for all the reasons I've elucidated, I'd like to see case manufacturers stop catering to the old 1950s technology of the hard disk and develop some new chassis that do away with the 3.5in drive bays. Some high-end case brands made a similar move, and stopped supporting 5.25in drive bays last year, but a case with only 2.5in drive bays could be smaller still.

What's more, because SSDs barely emit any heat and can be tucked away behind the motherboard, there's potential for far better airflow to the components that need cooling, such as the graphics card, CPU and motherboard. **CPC**

James Gorbolt has been building, tweaking and overclocking PCs ever since the 1980s. He now helps Scan Computers to develop new systems.



How 3D-printed rats could offer schools a vegetarian dissection

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600C 400C
ATX PC CASES



Intel® Core™ i7 6700K
6th Generation Intel® Core™ Processor

The 6th generation Intel® Core™ i7 processors deliver a new class of computing with a host of new features to power the next generation of desktops, laptops, and 2 in 1 PCs. Expect lighting fast speeds and peak performance through even the toughest of tasks and games.



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